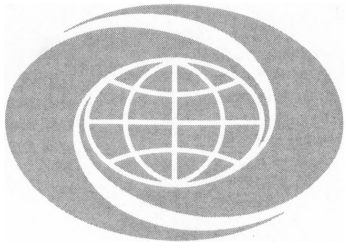

The World Book Encyclopedia

So-Sz Volume 18

Field Enterprises Educational Corporation
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The World Book Encyclopedia

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SOAP. See DETERGENT AND SOAP.

SOAP BOX DERBY is a coasting race for small motorless racing cars. The derby received its name because the cars sometimes are made from wooden soap boxes. In many cities, newspapers sponsor soap box derbies. The winners of these local races then attend the All-American and International Soap Box Derby, held every August in Akron, Ohio. The contestants, who are between 11 and 15 years old, build the racing cars. Rules govern the size and weight of the racer, how it is built, and how much money it may cost. The All-American and International Soap Box Derby attracts contestants from the United States, Canada, South America, and Europe.

SOAP OPERA. See RADIO (The Golden Age of Broadcasting); TELEVISION (Commercial Television).

SOAP PLANT is a tall herb of California which reaches a height of about 5 feet (1.5 meters). It grows from a bulb and has tufted leaves and white flowers streaked with purple. The leaves may be about $1\frac{1}{2}$ feet (46 centimeters) long. The flowers spread open in the afternoon. Indians used the bulb as a kind of soap.

Scientific Classification. Soap plants belong to the lily family, *Liliaceae*. They are genus *Chlorogalum*, species *C. pomeridianum*. JULIAN A. STEYERMARK

SOAP SCULPTURE is the art of carving figures from soap. It is best performed with a bar of soft white soap. A hard soap chips and leaves rough edges.

Scrape off all lettering or raised designs on the soap. Then, on paper, draw an outline of the shape that will appear on each side of the bar. Transfer the outline onto each side, using carbon paper under the design you drew on paper. Cut through the soap about $\frac{1}{4}$ inch (6.4 millimeters) outside the outline. It is best to start at the top and work downward. When you have cut away the excess soap, you have a flat piece in the general shape of your design. Work carefully, taking a little soap with each cut, until you reach the outline, molding and shaping the figure as you work. An orange stick, used in fingernail care, makes a good tool for scraping out small areas and shaping angles and curves, such as those in an animal's body or in facial features. Use your thumb or your fingers to smooth out rough surfaces.

Set the finished carving aside for several days to dry. Then polish it with a soft paper tissue. Use your finger tips and the palm of your hand to bring out highlights.

Soap sculpture can take on the lovely look of old ivory. You can preserve the carving with a coat of transparent lacquer, or you may paint it with colors.

The beginner should start off with simple designs and should practice cutting the soap until he becomes acquainted with this art medium. JACK WAX

SOAPBERRY is the name of a group, or genus, of trees and shrubs that bear fruit containing a soapy substance called *saponin*. Soapberry trees and shrubs grow in tropical regions, and as ornamental plants in the southern United States. The fruit has a fleshy or leathery berry. People in the tropics use the saponin from the berries for cleaning purposes. Soapberry plants are reproduced by seeds or by cuttings in early spring. They grow well in dry, sandy soil.

One type of soapberry is an evergreen tree that grows in India and Japan. This tree is about 60 feet (18 meters) in height. It has an orange-brown fruit which contains much saponin. Another species, grown in the tropical regions of the United States, has small white flowers with orange-brown fruit. It grows about 30 feet (9 meters) high. A third species grows in the U.S. from Missouri to Mexico. It has yellowish-white flowers and sheds its leaves in winter.

Western Ways

The Fruit of Soapberry yields a soapy substance called *saponin* which is used by people in the tropics for cleaning purposes.

Scientific Classification. Soapberries belong to the soapberry family, *Sapindaceae*. It makes up the genus *Sapindus*. The evergreen trees are species *S. mukorossi*, and *S. saponaria*. The deciduous tree is *S. drummondii*. J. J. LEVISON

See also TREE (Familiar Broadleaf and Needleleaf Trees [picture]).

SOAPSTONE, also known as *steatite*, is a soft rock composed mostly of the mineral talc. It feels soapy or oily and varies from white to gray and grayish-green.

Soapstone has many industrial uses. It is a good electric insulator and can easily be cut into various shapes. Because soapstone is not affected by high temperatures or acids, it is used for laboratory table tops, sinks, and some chemical equipment. Powdered soapstone is added to cosmetics, paper, and paint as a filler to improve these products. For example, soapstone gives paper a smooth surface. Tailors use pieces of soapstone called *French chalk* to mark cloth.

Soapstone is formed in the earth by changes in the structure and composition of an *igneous* rock such as peridotite (see IGNEOUS ROCK). These changes occur at low temperature and moderate pressure in the presence of water. Other kinds of rock that usually occur along with soapstone include dolomite and serpentinite. Soapstone, a *metamorphic* rock, forms in layers that vary greatly in thickness.

The United States ranks among the leading soapstone producers. Deposits occur in several states, including California, New York, North Carolina, and Virginia. Other countries that produce soapstone include Canada, France, and Italy. WILLIAM C. LUTH

See also TALC; METAMORPHIC ROCK.

SOARING SOCIETY OF AMERICA. See GLIDER (introduction).

SOBIESKI, JOHN. See JOHN III SOBIESKI.

SOBRERO, ASCANIO. See NITROGLYCERIN.

Pictorial Parade

Soccer Is One of the World's Most Popular and Exciting Sports.

SOCCER is one of the most popular sports in the world. It is the "national sport" of several European and South American countries, and of many countries in Asia. Soccer games often attract huge crowds of up to 200,000 persons. Soccer's most famous international competition, the World Cup matches, pits national teams from many countries against each other every four years. World Cup matches arouse as much interest and excitement in many countries as the World Series does in the United States each October.

In a soccer game, two teams of 11 men each try to knock a round ball through the opponent's goal. The speedy, muscular players wear only shirts and shorts, heavy knee-length socks, and cleated soccer shoes. Some players wear shin guards. The team that scores the most goals wins the game.

Only the goalkeepers, playing within a certain area, can touch the ball with their hands. Other players must kick it with their feet or hit it with their heads or bodies. Acrobatic soccer players leap high to bounce the ball away with their heads or turn in midair to kick the ball back over their heads.

Soccer is a tough, fast, exciting game that requires great physical endurance. Play rarely stops, and the players move up and down the field almost continuously. Play is stopped only when a goal is scored, a foul occurs, or if a player is seriously injured. A player taken out of a game cannot play again in that game. So soccer players often stay on the field despite injuries.

In Great Britain, soccer is called *football* or *association football*. The word soccer comes from *assoc.*, an abbreviation for *association*. American and Canadian football and rugby developed from soccer.

George E. Fishwick, the contributor of this article, is Editor and Publisher of the National Soccer News.

Soccer Field and Equipment

The Field. The size of the field may vary. In international competition, for example, the field may be from 110 to 120 yards, or 101 to 110 meters, long. The width may extend from 70 to 80 yards, or 64 to 75 meters. For college competition in the United States, the field may be from 110 to 120 yards (101 to 110 meters) long and 65 to 75 yards (59 to 69 meters) wide.

The boundary lines on the long sides of the field are called *touch lines*. Those on the short sides are called *goal lines*. When a player knocks the ball out of bounds, play stops until a player from the opposing team kicks or throws the ball into the playing area. The *halfway line* runs across the center of the field, halfway between the two goal lines.

The Goals stand in the center of the goal lines. Each goal consists of two wooden posts 24 feet (7.3 meters) apart and joined at the top by a crossbar that is 8 feet (2.4 meters) above the ground. A net is usually attached to the back of the crossbar and posts and pegged to the ground behind them. The net is helpful, because it stops the ball when it goes in the goal. In this way everyone can be sure that the ball has passed between the posts and under the crossbar to score a goal.

The Goal Area is a rectangle in front of each goal. It is 60 feet (18 meters) wide and extends 18 feet

(5.5 meters) in front of the goal. The goalkeeper cannot be charged by an opponent in the goal area, unless he is holding the ball and has both feet on the ground.

The Penalty Area is 132 feet (40.2 meters) wide and extends 54 feet (16.5 meters) in front of the goal. The penalty area is important, because defenders are seriously penalized if they break certain rules in that area. In such cases, a member of the offensive team gets a kick from the *penalty spot* 12 yards (11 meters) in front of the goal. Only the goalkeeper can attempt to block the kick.

The Ball is a leather casing inflated by a rubber bladder. A ball about 27-28 inches (69-71 centimeters) in circumference is used for adult games and one about 25 inches (64 centimeters) is generally used by children.

Soccer Rules

The Officials are the *referee* and two *linesmen*. The referee acts as the timekeeper and enforces the rules. He blows a whistle to stop and start play whenever (1) a goal is scored, (2) the ball goes out of bounds, (3) a player commits a foul, and (4) play is stopped for an injury. He may put a player out of the game for repeated fouling. A linesman stands on each touch line and decides which team throws the ball in when it goes out of bounds. The linesmen can also signal the referee when they see a player commit a foul or an offside.

Time. Most games last 90 minutes. Games are divided into two halves, and there is usually a short rest period between the two halves. Sometimes, the teams play an overtime period to determine a winner if the score is tied at the end of the second half of the soccer game.

Starting Play. Before a game starts, the team captains flip a coin to decide which team will kick off and to choose the goals their teams will defend. The teams change goals at the beginning of the second half, and the team that did not kick off to start the game kicks off for the second half.

Teams kick off from the *center spot*, a point in the middle of the halfway line. Players line up on their own half of the field with three players on the kicking team generally standing close to the ball. Opponents must be at least 10 yards (9 meters) away from the ball. One of the attackers kicks the ball forward to a teammate to start play again. Play resumes with a kickoff after a goal has been scored.

Fouls. The referee may penalize a team for a foul by sending the offending player off the field for the rest of the game, and perhaps awarding a free kick to the opponents. The kick may be a *direct free kick*, a *penalty kick*, or an *indirect free kick*.

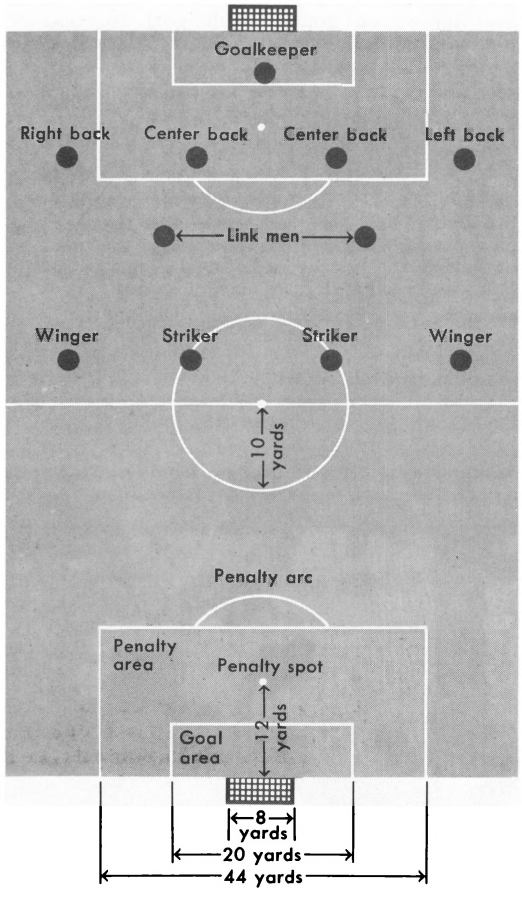
A direct free kick is taken toward the opponent's goal from the spot where the foul occurred. Opponents must stay at least 10 yards (9 meters) from the ball. A direct free kick may be awarded for (1) deliberately kicking or attempting to kick an opponent; (2) tripping, striking, holding, or pushing an opponent; (3) deliberately running into an opponent, and (4) jumping so as to endanger another player while trying to get the ball. If a player other than the goalkeeper touches the ball with his hands, the other team is awarded a direct free kick.

A penalty kick is awarded if a defender commits one of these fouls within his own penalty area. The offended team takes the penalty kick from the *penalty spot*, 12 yards (11 meters) directly in front of the goal. All players, except the opposing goalkeeper and the kicker, must stand outside of the penalty area.

The referee awards indirect free kicks for less serious fouls. The kicker must kick the ball so that it touches another player before it enters the opponent's goal. All opponents must stay at least 10 yards (9 meters) from the ball. Indirect free kicks are awarded for (1) dangerous play such as kicking the ball when the goalkeeper is holding it, (2) blocking an opponent, (3) pushing an opponent when the ball is not nearby, and (4) running into the goalkeeper when he is not holding the ball, when he is in his goal area, or when he is not blocking an opponent. The referee awards an indirect free kick against the goalkeeper if the goalkeeper takes more than four steps with the ball before releasing it.

The referee also awards an indirect free kick if a player is offside. Generally, an attacking player who is in his opponent's half of the field is offside if he is between the ball and the goal line. But he is not offside if (1) two opponents are closer to their goal line than he is,

A Soccer Field is a rectangular area divided by the halfway line, which runs across the center of the field. The defensive 4-2-4 position, *below*, is often used after the kickoff.



(2) he moved between the ball and goal line after a teammate kicked the ball, (3) the ball touched an opponent, or (4) he received the ball from a *goal kick*, a *throw-in*, a *corner kick*, or a *dropped ball*. These terms are explained in the table *Soccer Terms* elsewhere on this page.

Soccer Players

A soccer team is divided almost equally into attackers and defenders. As the teams line up on either side of the halfway line to start a game, the first line for each team has five forwards. They are the left and right outside (*wing*) players; a center forward; and left and right inside players. The second line consists of the left, center, and right halfbacks. The left and right fullbacks play in front of the goalkeeper.

After the kickoff, players often change their positions, making new formations. The most popular formation is the 4-2-4. This formation provides a tight defense against the opposing team. It uses four *defenders*—a right back, left back, and two center backs—in front of the goal. Two *link men* in the middle line play both defense and offense. Four forwards are in the first line. The forwards include two *strikers* flanked by two *wingers*.

SOCCER TERMS

Goal Kick is made by a defender when a ball last touched by a member of the attacking team passes over the goal line without going into the goal. He must kick the ball from inside his team's goal area, and it must go beyond his team's penalty area.

Corner Kick is made by an offensive player when a ball last touched by a defensive player passes over the goal line without going into the goal. The player kicks the ball from the nearest corner of the field.

Throw-In takes place after a player knocks the ball over one of the touch lines. A member of the other team throws the ball back into play. The thrower must have both feet on the ground either on the touch line or outside the playing area and he must throw the ball with both hands from above his head.

Dropped Ball. The referee drops the ball onto the ground between opposing players. This starts play again after the referee has stopped it for some reason other than foul, such as injury to a player.

Forwards are chosen for their scoring skill. They must react quickly; be able to dribble, pass, and move the ball accurately; and shoot hard with either foot. They attempt to force the opposing players out of position and then quickly to move through the opening and knock the ball into the opponent's goal.

Another popular formation, the 4-3-3, uses four defenders, three link men, and three forwards. Some teams use this formation alternately with the 4-2-4. Other formations may also be used. The purpose of changing formations is to use each player's special abilities. Different formations also help upset the opposing team's style of playing.

The goalkeeper is the only player who may use his hands and arms to stop the ball. He must move quickly to all parts of the penalty area near the goal to stop shots or take the ball from the opposing team.

Soccer Skills

Kicking includes those kicks that (1) attempt to score a goal, (2) put the ball in play, or (3) put the ball into a particular area of the field. Good players should be able to kick the ball well with either foot. A player who can kick best with his right foot generally plays on the right side of the field, and a left-footed kicker will play on the left side. For example, a left wing forward must be able to kick the ball well with his left foot.

A player may kick the ball with (1) his *instep* (top of the foot), (2) the outer or inner sides of his foot, or (3) his heel. The instep is perhaps the most effective kick used in soccer. A player can control the length, accuracy, and power of his kick much better with the instep.

Players kick with greater accuracy if they kick the ball so that it travels close to the ground. A player about to kick the ball along the ground should place his nonkicking foot near the ball. He should keep his head down and his eyes on the ball. He swings the kicking leg so that his foot hits the ball squarely. After his foot hits the ball, it should *follow through* (continue to move forward) to make the ball travel in the right direction and to keep the ball low.

To *chip* the ball, a player kicks it with his instep or the inside of his foot, lifting the ball over the head of an opponent. A player who chips cannot always be sure that the ball will travel the right distance and in the

A Soccer Player Tries to Score a Goal with a Header. He dove through the air, *right*, and hit the ball with his forehead, trying to knock it past the goalkeeper, *left*.

Pictorial Parade

right direction. Also, an opponent may anticipate the chip, back up quickly, and intercept the ball with his head or his body.

Other common kicks are the *volley* and the *half volley*. A player volleys when he kicks hard, just as the ball bounces off the ground. Volleys make powerful shots, but the ball is likely to go over the goal's crossbar.

Passing the ball to teammates is one of the most important skills in soccer. For accuracy, especially for quick, short passes, a player usually passes with the inside of his foot. Quick passes often fool opponents who are unable to recover in time to get the ball or get into the proper defensive position. Most passing is done to the right or left, but soccer players also pass the ball forward to a teammate.

A player sometimes passes the ball 20 yards (18 meters) or more with the inside of his foot. But if he wants to make a long pass, he is much more likely to reach a teammate by kicking the ball with his instep. The ball travels much faster this way and it is much more difficult for opponents to intercept it.

Players occasionally *back-heel* (pass the ball backwards by kicking it with the heel). Players sometimes use the back heel to send the ball to a teammate in one direction after getting the opposing players moving in the opposite direction.

Dribbling means to move the ball down the field by kicking it gently or nudging it with one foot to the other. Dribbling allows the player to keep the ball in his possession as he runs. By faking with his head or body to go one way, then actually going in another direction, a player may dribble quickly past several opponents. The ball will always be very close to his feet as he moves down the field.

Trapping occurs when a player uses his chest, thigh, foot, or his head to stop a ball and gain control of it. He may wedge it between his foot and the ground or allow it to hit his chest, thigh, or head and drop to the ground at his feet. If it bounces even a foot's length away, the player is likely to lose it to an opponent.

Heading means hitting the ball with the head. Forwards score many goals by running into the goal area as the ball is kicked there, and heading it into the goal. Good players can head the ball long distances. Goalkeepers seldom head the ball, because the rules allow them to use their hands.

Players head the ball with their foreheads. A player may head the ball directly from the front, or flick it with his head. If a player heads the ball with the top or back of his head, he cannot control the ball as well, and the impact of the ball as it hits may stun him.

Tackling is hooking or kicking the ball away from an opponent with the feet. In the most common type of tackle, a player faces his opponent and lunges at the ball, reaching with one foot to take it away from his opponent. In the *sliding tackle*, the player slides along the ground with one leg extended to kick the ball away from his opponent. In the shoulder charge, the player meets shoulder to shoulder with his opponent and tries to move him away from the ball. Players must never push with their elbows or arms, or deliberately kick or trip an opponent.

Soccer History

A game similar to soccer was probably played as early as 400 B.C. by the Chinese. In the A.D. 200's, the Romans played a game in which two teams tried to move a ball across a line on the field. During the 1100's, London children played a form of soccer in the streets.

During the early 1800's, many English schools played a game similar to soccer. The players made a number of rules that changed and developed the game. But each school interpreted the rules differently. In 1848, an association of school representatives met at Trinity College, Cambridge, to draw up the first set of rules.

In 1863, representatives of English football clubs

A Soccer Player Kicks the Ball with the instep or inside of his foot. He kicks with his instep when trying for a goal, *top*. He uses the inside of his foot to pass to a teammate, *bottom*.

The New York Times

A Soccer Player Tackles an Opponent to knock the ball away from him. He usually slides one leg in front of his opponent's feet to kick the ball away from him, *below*.

Wide World

WORLD CUP FINALS

1930	Uruguay 4, Argentina 2	(in Montevideo)
1934	Italy 2, Czechoslovakia 1	(in Rome)
1938	Italy 4, Hungary 2	(in Paris)
1950	Uruguay 2, Brazil 1	(in Rio de Janeiro)
1954	West Germany 3, Hungary 2	(in Bern)
1958	Brazil 5, Sweden 2	(in Stockholm)
1962	Brazil 3, Czechoslovakia 1	(in Santiago, Chile)
1966	England 4, West Germany 2	(in London)
1970	Brazil 4, Italy 1	(in Mexico City)
1974	West Germany 2, The Netherlands 1	(in Munich)

founded the Football Association. In 1871, the association introduced the Football Association Challenge Cup Competition. This competition is still one of the most famous in soccer. Professional soccer began in 1885 in England, and three years later 12 clubs formed the Football League of England.

Soccer began to spread throughout the world in the late 1800's. By 1900, associations were founded in Belgium, Chile, Denmark, Italy, The Netherlands, and Switzerland. In 1904, the national associations founded the *Federation Internationale de Football Association* (FIFA). Soccer rules are made by a 20-man board made up of equal numbers of representatives from the FIFA, England, Northern Ireland, Scotland, and Wales. The FIFA, which has over 130 members, supervises international matches, which have become an important part of soccer.

In 1930, Jules Rimet, a Frenchman who was president of the FIFA, presented a cup for the winner of an international competition. This competition is now called the World Cup, and its winner is determined in a famous series between national teams from many countries. The World Cup games are held every four years.

Soccer was the only form of football played in the United States until the mid-1800's, when American football became popular. Many U.S. and Canadian universities and colleges still have soccer teams.

The United States Soccer Football Association (U.S.S.F.A.), founded in 1913, is a member of the FIFA. Until the mid-1960's, it was mainly concerned with amateur soccer. In 1967, professional teams began play in the United States. GEORGE E. FISHWICK

See also RUGBY FOOTBALL; WORLD (color picture); CHILE (picture); PELÉ.

SOCHE, *SWAH CHUH,* or YARKAND, *yahr KAND* (pop. 80,000), is a trading center in southwestern Sinkiang, an autonomous region of China. It lies about 700 miles (1,100 kilometers) north of New Delhi, India (see CHINA [political map]). The city has been a station on Asian trade routes since ancient times. It produces carpets, embroideries, cotton, silk, and wool.

SOCIAL AND REHABILITATION SERVICE (SRS) is an agency of the United States Department of Health, Education, and Welfare. It was formed in 1967 to bring together in a single organization the department's social service and rehabilitation programs and its income support programs for needy Americans. The agency has five major divisions. (1) The *Rehabilitation Services Administration* administers programs that aid physically and mentally handicapped persons. (2) The *Community Services Administration* administers the agency's social service programs for children and adults. (3) The *Administration on Aging* administers programs that help aged persons. It also gathers and distributes information on the problems of old age. (4) The *Medical Services Administration* is responsible for Medicaid and other medical assistance programs for needy persons administered by states and local communities. (5) The *Assistance Payments Administration* handles payments involved in federal-state aid programs for the needy.

Critically reviewed by the SOCIAL AND REHABILITATION SERVICE

SOCIAL CHANGE refers to any significant change in the structure of society. Short-lived changes, such as changes in the employment rate, do not produce social change. Nor do fads, fashions, or temporary changes in ideas and behavior. The election of a new president is not social change. But replacement of the presidency with a dictatorship changes the structure of government and is thus a social change. Most sociologists recognize four main types of social change.

One type of social change involves changes in the number and variety of positions and social roles. When we say that an industrial society is more complex than a peasant society, we mean that it has many new and specialized jobs, such as computer programming, conducting cancer research, and piloting a spacecraft.

A second kind of change occurs in the obligations or duties attached to positions. For example, parents are no longer responsible for educating their children. They give this job to teachers and schools.

These two types of change lead to a third type—new ways of organizing social activities. The establishment of kindergartens occurred partly because the children of working mothers needed care. Other educational changes took place in response to occupational needs. For example, junior colleges were established for advanced—but not university-level—education.

A fourth kind of social change involves the redistribution of facilities and rewards, such as power, education, income, and respect. In 1950, for example, about half the people in the United States with substandard incomes were nonwhites. Today, about a fourth of the nation's poor are nonwhites.

Sometimes societies evolve gradually. At other times, they change abruptly, as in times of revolution. Change can result from planning, or it can be unintentional. Every society changes, but not all change at the same rate or in the same direction. Revolutionary change is often accompanied by violence.

Most changes benefit some people more than others and may penalize some people. For this reason, some resistance to change is inevitable. Many social changes have had both beneficial and undesirable consequences.

As change improves conditions, people's expectations grow. They become dissatisfied with current achievements and demand more. Sometimes they demand changes in the law. But when people believe that their grievances cannot be corrected within the system, they call for more radical change—for revolution.

For centuries, men have sought simple explanations for change, often emphasizing single factors. The German social philosopher Karl Marx claimed that the economy is the prime source of social change. Today, scholars believe that such explanations do not account for the complicated events of social change. Many sociologists think that societies are systems. Change in

one part of a society, they believe, leads to change in other parts, with no one part having priority. For example, the automobile—a product of technological change—created changes in where people live and in their leisure activities. HARRIET ZUCKERMAN

See also CULTURAL LAG; CULTURE (How Cultures Grow and Change); SOCIAL ROLE; SOCIOLOGY (Social Change).

SOCIAL CLASS is a group of persons in a society that have about the same social standing. Social classes exist because people usually classify one another into more or less distinct groups based on such factors as wealth, power, prestige, ancestry, religion, and occupation. Often, people rank these groups in their minds, considering some "better" than others. Social scientists call the groups *social classes* and describe the process of social ranking as *social stratification.*

All societies seem to have some system of social stratification. That is, there are no "classless" societies. In the United States and other Western democracies, the class system is usually informal, and social scientists disagree on how to classify the groups that seem to exist. Some arbitrarily divide the American people into three classes—upper, middle, and lower. Other social scientists add a fourth class—the working class—between the middle and lower groups, while others substitute the term *working class* for *lower class.*

In the late 1940's, social anthropologist W. Lloyd Warner identified six social classes in a New England community he studied. He called them (1) upper-upper class, (2) lower-upper class, (3) upper-middle class, (4) lower-middle class, (5) upper-lower class, and (6) lower-lower class. The characteristics of each group are described in *Yankee City Series.* Although some sociologists disagree with Warner, his classifications have been widely used by scholars and the public.

In most Western democracies, persons can move from one category to another and there are few clear-cut signs as to which group a person belongs. But in some societies, people are born into a certain social class, and change to another class is difficult if not impossible. A class with such rigid barriers is called a *caste.* A person belongs to the caste of his parents. Laws and traditions severely limit the social contacts he may have with members of other castes. India has a more firmly established caste system than any other country. See CASTE; INDIA (Hinduism).

Communism has long had the goal of achieving a "classless" society without distinctions based on rank or birth. But in the Soviet Union and other Communist countries—just as in the non-Communist world—some groups of persons, such as government officials, have much more power, wealth, and prestige than others. See COMMUNISM (Marxism); RUSSIA (Way of Life).

How Persons Are Ranked. Various methods are used to compare and rank individuals and groups. A social scientist may use such objective measures as how much money a person earns. Or members of a group may rank one another, or place themselves on the class ladder. Surveys show that the way persons rank themselves depends on the categories that are used. If they are told to place themselves in either the upper, middle, or lower class, most place themselves in the middle class. But when the working-class category is included, the majority rank themselves in that class. Almost all are unwilling to say they belong to the lower class.

Occupation is one of the best indicators of class, because people tend to agree on the relative prestige they attach to similar jobs. Those at or near the top rung of the prestige ladder usually have the highest incomes, the best education, and the most power. In general, persons who hold positions of leadership and responsibility—such as heads of government and industry—rank at the top. Persons whose jobs require long training and superior intelligence—such as physicians, scientists, college professors, and university-trained professional people—rank next in order of prestige. Persons with low-paying positions that require little training or formal education—such as unskilled laborers—rate at the bottom. People in both capitalist and Communist countries, as well as those in both economically developed and underdeveloped countries, rank these jobs almost exactly the same way.

Class Differences. A person's social status affects his behavior, values, and style of life. Upper-class members, for example, are aware of their privileged position and try to preserve it by encouraging marriage within their own class. Persons with higher status usually back conservative political parties and candidates, because they wish to maintain the existing system of inequality. Socially, the upper class is noted for its elegant and refined style of living.

Most members of the middle class enjoy a better-than-average education and standard of living. Middle-class values are usually the dominant values in a society. In the United States, the middle class stresses thrift, self-improvement, and economic success and job advancement. Members of this group believe it is important to own property and to conform to the community's standards on morality and respectability. Generally, they send their children to college, and they are prominent in civic and governmental affairs.

Members of the lower class usually have less formal education and training than those of the middle- and upper-classes, and have unskilled or semiskilled jobs. Because many lower-class members live in poverty or near-poverty, they are more concerned with immediate needs than with long-range goals.

Why Social Classes Exist. Most sociologists who study stratification believe a society must have a system of rewards to encourage some men to undertake the key jobs. Persons who hold these positions usually need much education and training, and often work under great strain. For men to seek out and to work efficiently in such socially crucial occupations, society must see that they are well rewarded. Therefore, these sociologists argue, stratification and unequal reward are necessary for a division of labor with some persons taking greater responsibility than others.

A group of sociologists influenced by the teachings of Karl Marx rejects this interpretation. This group argues that differing rewards are due to variations in power positions. For example, the people who control the resources that men value or who control the police or other instruments of force have the highest income and status. This group suggests that stratification exists in any social organization that involves a chain of command. SEYMOUR MARTIN LIPSET

SOCIAL CONTRACT. See DEMOCRACY (French Contributions).

SOCIAL CREDIT PARTY. See ALBERTA (History).

SOCIAL INSECTS. See ANIMAL (Animals That Live Together); ANT (The Ant Colony); BEE (The Honeybee Colony; Kinds of Bees); TERMITE; WASP.

SOCIAL LEGISLATION. See CHILD LABOR; HOUSING; LABOR (The Federal Government); PUBLIC HEALTH (Health Laws); SOCIAL SECURITY; WOMAN; MEDICARE.

SOCIAL PSYCHOLOGY is the study of social behavior, including its origins and effects. Social psychologists study the influence that persons have on one another individually and within groups. They also study relationships between groups. All these relationships are part of the process of *social influence*. The effects of social influence can be seen in conformity, leadership, prejudice, morale, attitude change, and child-rearing. Social psychology includes all these areas of study.

Social psychologists also study learning, adjustment, and other psychological processes that are affected by social factors. These psychologists examine the part played by *culture* and *society* as sources of social influence. A culture is a way of life that is transmitted to children from generation to generation. It dictates various social practices, including education, language, family relationships, child-rearing customs, and economic and political forms (see CULTURE). A society is made up of people who are organized to live according to a culture. The study of culture and society reveals much about the learning and adjustment processes which lead to normal and abnormal social behavior.

Through research, social psychologists try to understand problems of intergroup tensions and prejudice, industrial morale, and international relations. Social psychology is therefore both a basic field of social science and an area of applied activity.

Social psychologists use various research techniques, including observing and interviewing people in their own surroundings. A technique of growing importance is experimentation in a *social psychology laboratory*. Here, psychologists can control and alter certain social conditions and measure the effects produced. For example, to study conformity in group situations, a psychologist might ask five persons to make a simple judgment, such as judging which of two lines is longer. If four members of the group are told beforehand to give the wrong answer, the fifth person often will give that response, too. However, if the procedure is varied slightly so that the fourth person is instructed to give the correct judgment, then the fifth person usually does not attempt to conform to the majority opinion.

Social psychologists concentrate on three general problem areas: (1) social interaction in groups and organizations, including the study of conformity and leadership; (2) the effects of propaganda and other forms of communication on attitude change; and (3) social learning and personality development.

Social Interaction

The term *social interaction* refers particularly to contact between persons who depend on each other. There are formal and informal social interactions.

In formal interaction, behavior is dictated by cultural forms, particularly by *social roles*. For example, society determines certain patterns of social behavior in relationships between parent and child, husband and wife, teacher and student, and employer and employee. In informal interaction, the form of the relationship depends more on the satisfactions of the persons themselves. Examples of informal interaction include friendships among strangers who meet while traveling.

Whether or not we continue a relationship depends on *interpersonal attraction* (liking or disliking a person). This is especially true in informal interaction. Researchers have found that most of us like a person if his attitudes are similar to ours. The satisfying continuance of interaction depends on a process of *social exchange*. That is, we usually expect that the rewards we give another person will be exchanged for rewards from him. Such an exchange occurs, for example, when we approve of a person and he approves of us. When we give a favor to a friend, we often receive the same kind of favor in return. Sometimes the reward received (tickets to a play) is not the same as the reward given (the loan of a football). The important factor is that the reward be important to the recipient.

In groups, social interaction usually involves the relationships of many people with one another. The study of these relationships is called *group dynamics*, and makes up a major area of laboratory experimentation.

Experiments have provided much information about factors affecting group performance and satisfaction. The most important of these factors is *group cohesiveness*, the attraction of a group for its members. If the members are strongly motivated to belong to a group, they are more likely to conform to its *norms* (standards of conduct). In groups that are more cohesive, the members are inclined to interact and communicate more. The members also tend to have higher morale, in the sense of greater shared enthusiasm for the group and its activities. Morale is not necessarily a direct gauge of good performance. But morale and good performance have been found to be associated with each other and with cohesiveness. See MORALE.

Several factors help determine who will succeed as leader of a group. These factors include the task the group performs and the nature of the group's situation—its size, the composition of its membership, its history, and its resources. A leader's ability to influence his followers depends on how they regard him in the light of their situation. A leader's status and influence rise when the members believe he is providing resources which help the group in its task and the attainment of its goals. The leader then has a greater opportunity to introduce changes through actions that might be considered nonconformity for others in the group.

Attitudes and Attitude Change

A *social attitude* is a view of people, things, or events. It can be either favorable or unfavorable, and influences a person to respond in a particular way. Every person has many attitudes, some of which are more important than others in determining responses. Some attitudes are also more likely to change than others. A person may change one of his attitudes because it conflicts with another attitude, or with his behavior, or with new information he has acquired.

Some social psychologists study *cognitive dissonance*,

which arises, for example, when a person is required to do something even though an attitude prompts him to do the opposite. In such a situation, the person may change his attitude to fit his behavior, especially if he does not feel too greatly pressured to do so.

Other researchers study attitude change through research on *communication effects* from a communicator, such as a propagandist. They examine the relationship between how a person evaluates the new information and the way he perceives the communicator.

Social Learning and Personality Development

Another area of social psychology is *socialization*, the child-rearing process. Most social psychologists emphasize learning as the central feature of socialization. They examine the ways in which socialization affects a child's personality, including his attitudes and social behavior. Their findings show that an important aspect of socialization lies in the child's identification with his parents and his friends.

The way a child imitates others is determined partly by his dependence on his parents, especially during early childhood. In general, the closer the relationship between parent and child, the more the child adopts characteristics from his parents. The child's pattern of identification is also determined by the balance of discipline and affection from his parents. This balance influences the development of his conscience, his attitudes toward himself, and his relations with friends.

Personality development is also affected by the interaction between the child and certain groups. These groups include his friends, his school, his church, and other community organizations. Groups in which a person values his membership highly are called *reference groups*. They have a greater influence on his personality than other groups. EDWIN P. HOLLANDER

Related Articles in WORLD BOOK include:

Alienation	Human Relations	Power (social)
Developmental Psychology	Industrial Psychology	Prejudice
Group Dynamics	Learning	Psychology
	Personality	

SOCIAL ROLE is a set of attitudes and actions expected of someone in a specific social position. For example, a teacher is expected to enjoy working with young people; to be patient, firm, and fair with students; and to cooperate with the school principal. Individuals respond in different ways to such expectations, but all are limited and restrained by the behavior pattern that is considered appropriate for them.

Most individuals have several different social positions, and thus several different roles. For example, a man may be a son, husband, father, lawyer, school board member, and president of the local bar association. In each of these positions, he is expected to behave in a certain way toward others, including his family, his clients, school officials, and his co-workers.

Throughout life, persons learn to play the roles they will eventually perform. For example, boys learn the appropriate patterns of behavior for men partly by observing and identifying with their fathers and older brothers, and partly because feminine and "sissy" behavior is discouraged or punished. Persons also learn roles in school, from friends, and on the job.

Confusion and uncertainty over roles or dissatisfaction with certain required roles sometimes causes psychological problems. *Role conflict* may result when the demands of one role interfere with those of another. For example, a man might frequently work overtime to improve chances of a job promotion. But he might also feel guilty about spending too much time away from his family. WOLF HEYDEBRAND

See also PERSONALITY; SOCIAL PSYCHOLOGY.

SOCIAL SCIENCE. Scholars generally identify three categories of knowledge: (1) the natural sciences and mathematics, (2) the humanities, and (3) the social sciences. The natural sciences concern nature and the physical world. The humanities try to interpret the meaning of man's life on earth rather than to describe his physical world or society. The social sciences focus on man's life with other men in groups. They include anthropology, economics, history, political science, sociology, criminology, and the science of law. Some scholars also regard education, ethics, philosophy, and psychology as social sciences. Certain studies in other fields, such as biology, geography, medicine, art, and linguistics, may be said to fall within the broad category of the social sciences.

Relationship to Natural Sciences. Scholars in the social sciences have developed certain ways of studying people and their institutions. Generally these scholars have borrowed from the natural sciences the methods they use to study, simplify, and classify the observed behavior of human society. Their observations of the regularity of human behavior lead them to form *hypotheses* (propositions) and then to test their validity.

The social sciences are still a comparatively new field of learning. History and geography have existed as separate disciplines for a long time. But attempts to organize man's endeavors into systems of economics, sociology, and political science are so new that many scholars doubt that the scientific method can be used with complete success to know and control any aspect of society. They see a wide gulf between the clear and exact nature of the natural sciences and the inexact nature of the social sciences. One of the most powerful tools of the natural sciences is the controlled experiment. Such a method is difficult to use in experiments involving human beings.

Relationship to Humanities. The interdependence of the social sciences and the humanities is important. In a social science, the scholar must note the underlying values of a society, which are stated by the scholars of the humanities. For instance, suppose a political scientist wishes to determine scientifically whether a particular community should have an authoritarian or a representative form of political organization and control. He must first learn the importance which that community attaches to such values as the right of the individual to differ with authority, or to have a voice in policy and laws. Then he can formulate the principles that govern its political action. PAUL R. HANNA

Related Articles in WORLD BOOK include:

Anthropology	Ethics	Philosophy
Archaeology	Geography	Political Science
Civics	Government	Psychology
Criminology	History	Social Psychology
Economics	Law	Social Studies
Education	Linguistics	Sociology

SOCIAL SECURITY is a government program that provides cash payments or medical care to individuals. Social security includes three basic types of payments: (1) social insurance, (2) subsidized voluntary insurance, and (3) public assistance. *Social-insurance* payments are financed by taxes paid by workers and employers. Payments are made to persons after they have fulfilled certain conditions. *Subsidized voluntary insurance* is a program under which a person buys a policy and the government pays part of the cost. *Public assistance* involves government payments financed by general taxes and based on the individual's needs.

Most persons in the United States receive their social security protection from the provisions of the Social Security Act of 1935. But payments from the government do not provide the only form of security for most people. Private savings, home ownership, life insurance, annuities, hospitalization and health insurance, employer- and union-sponsored benefit programs, and other plans offer additional protection.

Every major country has a social security program. In the 1880's, Germany became the first country to adopt workers' compensation and old-age pension laws. In the United States, the first trade union unemployment insurance plan was adopted in 1831, and the first private pension plan in American industry went into effect in 1875. Wisconsin in 1911 passed the first state workers' compensation law to go into effect and be held constitutional. Great Britain passed its workers' compensation act in 1897, and an old-age pension law in 1908. Canada's first social-insurance programs began in the 1940's.

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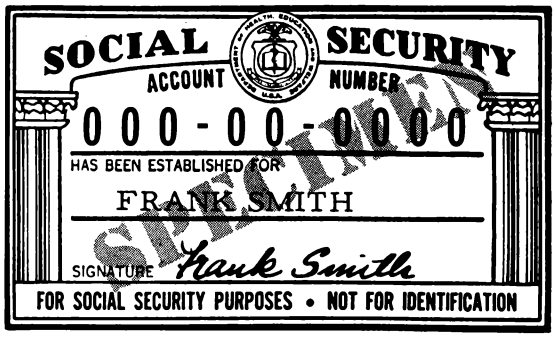

A Social Security Card bears a worker's name and account number. The first three digits identify the office issuing the card.

Social Insurance

The social-insurance program in the United States covers (1) old-age, survivors, and disability benefits; (2) hospital insurance; (3) unemployment insurance; (4) workers' compensation; and (5) sickness insurance.

The Social Security Act of 1935 provided for federally administered old-age insurance. Before then, U.S. social security laws included only workers' compensation, old-age and mothers' assistance, and general relief. Later laws widened coverage, liberalized qualifications, and increased benefits. The 1935 law also established unemployment insurance on a state-by-state basis.

In 1965, Congress set up a system of hospital and related health insurance benefits under the Social Security Act. A voluntary system of insurance to pay doctors' bills also began. Both programs are called *Medicare*. At first, they applied only to persons 65 or older. Now they also apply to disabled persons who have been receiving social security benefits for at least two years.

Old-Age, Survivors, and Disability Insurance is administered entirely by the federal government. The Social Security Administration directs these programs.

Coverage. The plan covers about 90 out of 100 workers in the United States. Of those not covered, about half come under special plans for railroad workers and for federal, state, and local government employees. Coverage is compulsory for most persons. Those not covered include some government employees, farm and domestic workers who are not regularly employed, and self-employed persons earning less than $400 a year.

Benefits are paid to retired workers and their dependents, to disabled workers and their dependents, and to survivors of workers who have died. Benefits are paid monthly, except for lump-sum death payments.

A worker may receive old-age benefits if he is 62 or older, and substantially retired from gainful work. The government considers him substantially retired if he earns $2,520 or less annually, or $210 or less in any month. He becomes eligible at the age of 72, regardless of his earnings. If he retires at 65, he receives full benefits. He may retire at 62 and get 80 per cent of the full benefits for the rest of his life.

The amount of a person's benefit depends only on his average earnings, not on his length of coverage or contributions to the program. Lower-paid workers receive a proportionately larger benefit than higher-paid workers. A person who works beyond age 65 without claiming benefits will, upon retiring or reaching age 72, whichever comes first, receive one per cent more in benefits for each year he has not claimed them.

The smallest benefit a worker can get at age 65 is $93.80 a month, and the largest is $484. A worker gets higher benefits if he has a wife of 62 or older, a child under 18 or disabled, or a child 18 to 21 and in school. The normal benefit for each dependent is half the worker's benefit. But a wife who claims benefits between 62 and 65 gets less. A family cannot receive more than 188 per cent of the worker's basic benefit, but the highest payment is $847 a month. Benefit payments are automatically adjusted to changes in the cost of living.

Eligibility. A person qualifies for old-age benefits if he has worked a certain length of time after 1936 on a job covered by social security. This employment does not have to be continuous. Generally, 10 years' employment is required. But persons now above or near the minimum retirement age do not need to have been covered for this length of time.

A totally disabled worker may receive monthly benefits for himself and dependents after six months of disability and if he is likely to be disabled for at least six more months. Additional amounts are paid for his

U. S. News & World Report

Social Security funds provide many benefits, such as cash payments or medical care. Medicare, a hospital and voluntary medical insurance plan, is financed through Social Security program funds.

wife if she is 62 or older, and for eligible children. A mother of eligible children receives benefits regardless of her age, if the children are under 18 or disabled. The disabled worker must have been in work covered by social security for 5 of the last 10 years. If he is under 31, lower requirements apply.

If an insured worker dies before or after his retirement, his dependents are eligible for monthly survivor benefits. Payments may go to his widow if she is 65; to his dependent parents if age 62; and to children and their mother just as in the case of a disabled worker. The widow can claim benefits at a permanently reduced rate between 60 and 65, or between 50 and 60 if she is disabled. Payments are based on the benefits the worker was receiving (or would have been receiving if he had been old enough to retire) when he died. A widow aged 65 or over receives 100 per cent of the worker's benefit. A dependent parent aged 62 or older receives 82½ per cent. A widow aged 60 receives 71½ per cent, and one aged 50 receives 50 per cent. A child or widowed mother receives 75 per cent. To be eligible, the worker must have been receiving old-age or disability benefits, or must have been eligible to receive old-age benefits if he had been old enough. Children, husbands, and parents of women workers may draw benefits under the same conditions that apply for male workers.

Payments. The government does not automatically pay social security benefits when a worker retires, becomes disabled, or dies. He or his survivors must file a claim at one of the more than 1,200 district offices of the Social Security Administration.

Payments to Uninsured Persons. Special benefits of $64.40 a month ($96.60 for married couples) apply for certain uninsured persons 72 or older who became 72 before 1968, provided they are not getting public-assistance payments. Benefits are paid by the Social Security system. The amount of benefit is reduced by the amount of any other government pension received. The money comes from general revenues.

Financing. A payroll tax in the form of a contribution shared equally by the employer and employee finances the Old-Age, Survivors, and Disability Insurance program. This tax, the F.I.C.A. (Federal Insurance Contributions Act) tax, is paid only on annual earnings up to $14,100 in 1975, with automatic adjustments thereafter as wage scales change. If a worker earns more than that, he pays no additional F.I.C.A. tax. From 1974 to 2010, an employee pays 4.95 per cent of all earnings up to the limit. His employer pays an equal amount. After 2010, each will pay 5.95 per cent. A self-employed person pays 7 per cent in all years.

Each payday, the employer deducts the tax from the worker's pay, adds an equal contribution, and sends it monthly or quarterly to the Department of the Treasury. A self-employed person pays quarterly. The tax for hospital insurance is paid with the Old-Age, Survivors, and Disability Insurance tax. The government puts all of these payments in the Disability Insurance Trust Fund and the Old-Age and Survivors Insurance Trust Fund.

Administration. Every person covered has an account number. An employer reports the number and earnings to the Social Security Administration. In the mid-1970's, this agency had active records on about 145 million persons. It does not keep a record of the contributions each person has paid, because these deductions do not accumulate with interest. A person's benefits have no direct relationship to his contributions.

In 1975, about 80 million persons held jobs covered by social security on an average day. They worked for about 5½ million employers. About 31 million persons received monthly benefits early in 1975.

In 1975, a total of 15 million retired workers had 3,500,000 eligible dependents receiving benefits. There were 2,200,000 disability beneficiaries with 1,600,000 eligible dependents. Survivor beneficiaries totaled 7,300,000 including 3,900,000 aged widows, 2,800,000 orphaned children, and 600,000 mothers of such chil-

dren. About 300,000 uninsured persons 72 or over received special payments.

Amounts Paid. The average retired worker received a monthly benefit of about $188 in early 1975, excluding any benefits for dependents. The average benefit for a retired worker with an eligible wife was about $315 a month. An aged widow received an average of $178, and a widow with two children got about $440. Disability beneficiaries had an average payment of $206, excluding benefits for dependents. Total benefit payments for 1974 were about $59 billion, and total contributions were $58 billion. Assets of the trust funds totaled $45 billion at the end of 1974.

Railroad Retirement is a separate system of social security for railroad workers. The Railroad Retirement Board, an independent agency of the government, administers this program of old-age, survivors, and disability benefits (see RAILROAD RETIREMENT BOARD).

Railroad workers pay a tax on their earnings at the same rate as do workers under the general social security system. Railroad employers pay a larger share. In 1975, workers and employers together contributed 21.2 per cent on earnings up to $1,175 a month. A worker with less than 10 years' railroad service has his wage credits transferred to the general social security system, and receives benefits from it. But, even though he has more than 10 years' railroad service, survivor benefits are based on his combined earnings in railroad and other work. These benefits are generally paid by the Railroad Retirement Board.

Hospital and Supplementary Medical Insurance. The *hospital insurance* is for all persons under the Old-Age, Survivors, and Disability Insurance system, and railroad pensioners who are 65 or older or who have been receiving monthly disability benefits for at least two years. It pays the cost for the first 60 days of hospital care (excluding the first $92) and all except $23 a day for the next 30 days. It also pays for skilled nursing-home care after the hospital. It does not pay doctors' fees. The *supplementary medical insurance* is a voluntary plan. It pays 80 per cent of doctors' bills and certain other related costs in excess of $60 a year. It costs $6.70 a month (which the government matches) and covers anyone 65 or older who signs up. It also covers any person who has been receiving social security disability benefits for at least two years. See MEDICARE.

Unemployment Insurance makes weekly payments to workers who have been unemployed or released from their jobs for more than one week. Generally, benefits are paid for as long as 39 weeks. Each state administers its own program. Railroad workers qualify under a separate federal plan. The federal government requires businesses to pay a 3.2 per cent tax on wages up to $4,200 a year. But it excuses 2.7 per cent of this tax if the employer's state has an acceptable unemployment-insurance system. The federal government uses the 0.5 per cent tax actually collected to pay grants to states for administering their insurance systems, to build up a fund from which states may borrow, and to pay extended unemployment benefits. Each state sets its own tax rate on employers. A few require a small contribution from workers. The state tax rates average about 2 per cent. In many states, benefits amount to about half a worker's earnings, with a maximum weekly payment of $60 to $80. See UNEMPLOYMENT INSURANCE.

Workers' Compensation. Persons suffering from industrial injuries or diseases may receive workers' compensation. In some states, the state government administers the program. In others, private insurance companies provide the payments, or compete with state funds. Coverage usually applies only to industrial and commercial workers. Benefits include medical care, cash benefits during temporary or permanent disability, and lump-sum or continuous benefits for survivors. The employer generally pays the entire cost of workers' compensation. The average rate is about 1.2 per cent of the payroll. See WORKERS' COMPENSATION.

Sickness Insurance provides weekly cash payments to persons unable to work because of illness due to disease or injury. The Railroad Retirement Board and five states—California, Hawaii, New Jersey, New York, and Rhode Island—sponsor such programs. Each plan resembles unemployment insurance or workers' compensation as to duration and amount of payments. In

EXAMPLES OF SOCIAL SECURITY PAYMENTS

	Workers' Average Monthly Earnings After 1950					
	$76 or less	$200	$400	$600	$800	$1,175
Retirement and Disability Benefits						
Monthly payment to retired worker at age 65 or disabled worker	$93.80	$171.40	$259.00	$343.90	$404.60	$484.00
Monthly payment to retired worker at age 62	75.10	137.20	207.20	275.20	323.70	387.20
Monthly payment to wife at age 65, or under age 65 with a child in her care	46.90	85.70	129.50	172.00	202.30	242.00
Monthly payment to wife at age 62	35.20	64.30	97.20	129.00	151.80	181.50
Survivors Benefits						
Monthly payment to widow at 65	93.80	171.40	259.00	343.90	404.60	484.00
Monthly payment to widow at 60, no child	74.90	122.60	185.20	245.90	289.30	346.10
Monthly payment to disabled widow at 50, no child	56.80	85.80	129.60	172.00	202.40	242.10
Monthly payment to widow under 62, 1 child	140.80	257.20	388.60	516.00	607.00	726.00
Maximum monthly family benefit	140.80	257.10	472.60	608.60	708.10	847.00
Lump-sum death payment	255.00	255.00	255.00	255.00	255.00	255.00

some systems, benefits are paid for maternity as well as for sickness. California also pays additional cash benefits for hospitalization. The employer, the employee, or both contribute to the sickness-insurance plan. The total contribution rate varies from about ½ to 1 per cent.

Public Assistance

Some state and local governments had their own public-assistance programs before 1935. But most of these plans were poorly organized or had strict residence requirements. The Social Security Act provides federal grants-in-aid to states that establish certain special categories of public aid and meet certain standards.

The 1935 law created three categories: (1) old-age assistance, or aid to the aged; (2) aid to the blind; and (3) aid to families with dependent children. In 1950, Congress added aid to persons who are permanently and totally disabled. In 1960, Congress established a federal-state program of medical care to help aged persons meet unusually heavy medical bills. In 1965, the medical assistance program was extended to needy persons of all ages. In 1974, three programs—old-age assistance, aid to the blind, and aid to the disabled—were combined into a single program called *Supplemental Security Income*. Persons receiving public assistance are generally allowed to earn small amounts of money without having their payments reduced. The Social and Rehabilitation Service carries out the federal government's responsibilities for joint federal-state public assistance programs. See SOCIAL AND REHABILITATION SERVICE.

Supplemental Security Income, also called *SSI*, guarantees a minimum income for persons who are 65 or older, blind, or disabled. The federal government administers and finances the program. In early 1975, SSI assured a monthly income of $146 for a single person and $219 for a couple. These amounts are automatically adjusted for changes in the cost of living. Social security benefits and other income, such as private pensions, count toward the guaranteed amount. Therefore, most people receiving such benefits or pensions get proportionately less supplemental security income—and usually none at all.

In 1974, about 2,100,000 persons aged 65 or older received SSI payments. About 75 per cent of them also received old-age insurance benefits. The average payment was about $70 per month, but many states supplemented the federal payment. Combined federal and state payments averaged as much as $120 to $150. Payments to those 65 or older totaled about $2,400,000,000, of which about a fourth was paid by the states.

About 75,000 blind persons also received SSI payments in 1974. The average federal payment was about $105, and many states supplemented the federal aid. Combined payments averaged as much as $160 to $200 in some states. Payments to the blind totaled about $130,000,000, of which the federal government paid about three-fourths.

In addition, about 1,500,000 disabled persons received SSI assistance in 1974. The average federal payment was about $120 a month. Many states supplemented the federal payments, and the average benefit was as high as $160 to $200 in some states. Payments to the disabled totaled about $2,700,000,000, of which nearly four-fifths came from the federal government.

Aid to Families with Dependent Children provides payments to needy children and to their parents or guardians. Children may become needy because their father died, deserted home, is unemployed, or has become too disabled to support them. Federal aid is based on the average payment of a state to each child and adult caretaker. In 1974, about 7,800,000 children in 3,200,000 families received payments. The average monthly payment was about $200 for each family and $80 for each child. Average state payments for individuals ranged from about $15 to about $90 a month. Total payments for 1974 amounted to about $7,600,000,000, with the federal government paying slightly more than half. See AID TO FAMILIES WITH DEPENDENT CHILDREN.

Medical Assistance provides care for public assistance recipients and others who do not have enough money to pay for such care. Payments to these recipients in 1974 amounted to about $12 billion, of which the federal government paid about half. See MEDICAID.

Other Public Assistance Programs include *General Assistance*, or *Relief;* and *Veterans' Welfare* programs. See WELFARE; VETERANS ADMINISTRATION.

Other Public Aid under the federal Social Security Act includes state-administered programs that are partly financed by federal grants. These programs cover maternal and child-health services, crippled children's services, and child-welfare services.

Social Security in Canada

Canada has a social-insurance program that is administered by the national government. A public-assistance program is shared by the national government and the provinces. It began in 1927. Unemployment insurance began in 1940, family allowances in 1944, old-age insurance in 1951, and hospitalization insurance in 1957.

Social Insurance. In Canada, one part of the program is called *old age security pensions*. Applicants must be 65 or older, and must have lived in Canada at least 10 years. They do not have to stop working to qualify. Special taxes pay for the program. All benefits were $112.95 in July, 1974. The benefits are adjusted every three months for changes in the cost of living.

The other part of the old-age program is the *Canada Pension Plan*. In Quebec, a similar plan is called the *Quebec Pension Plan*. Both plans operate on contributions from earnings much like the United States plan. The plans in Canada provide monthly benefits for retirement, disability, and survivors. They cover all employed persons who earn over $700 a year. In 1975, employer and worker each contributed at a rate of 1.8 per cent on wages between $700 and $7,400 a year.

The Guaranteed Income Supplement program, in July, 1974, provided up to $79.23 a month additional income to old-age security pensioners who have no sizable income from the Canada or Quebec pension plan, or from other sources. A married couple gets $140.72 a month. The benefits are automatically adjusted for changes in the cost of living.

Unemployment Insurance is for almost all employees in Canada. Workers pay 1.4 per cent of their pay up to $170 a week. Employers pay from 1.96 per cent. The

national government pays for excess benefits resulting from an unemployment level of over 4 per cent. Benefits amount to two-thirds of average covered pay. Payments may extend to 51 weeks, after a 2-week waiting period. Similar benefits are provided for sickness and maternity, but only up to 15 weeks. Employers having suitable private plans for such benefits may contract out of the government plan and pay a lower tax rate that applies only to unemployment benefits.

Medical and Hospitalization Insurance is paid in all Canadian provinces. Each province receives grants from the national government that cover about half the cost of medical and hospital services. The insured person and the province pay the remainder of the cost in a manner determined by each province.

Family and Youth Allowances are paid by the government to children under 18 who meet certain residence requirements. Children aged 16 and 17 must be in school or disabled. Payments average $20 a month per child, but each province may vary the amounts according to a child's age and the size of his family.

Public Assistance. Nearly all public assistance is provided through the Canada Assistance Plan, enacted in 1966. This plan is designed to provide cash assistance to all needy persons. The cost of the program is shared equally by the national and provincial governments. The provinces administer the plan, which largely replaced previous programs that provided help only to the aged, the blind, the disabled, and widowed mothers. Several provinces kept parts of the older programs while switching to the Canada Assistance Plan. See WELFARE (Welfare in Canada). ROBERT J. MYERS

Related Articles in WORLD BOOK include:

Aid to Families with Dependent Children	Pension
Beveridge, William H.	Townsend Plan
Insurance	Unemployment Insurance
Medicaid	Veterans Administration
Medicare	Workers' Compensation

SOCIAL SECURITY ADMINISTRATION (SSA), a United States government agency, administers the nation's social security program. This program provides retirement, disability, and death benefits for 9 out of 10 working Americans and their families. Under the plan, a retired or disabled worker or his dependents or survivors receive monthly cash payments. The SSA administers Medicare, a health insurance plan largely for persons 65 or over. It also administers the supplemental security income program, which guarantees an annual income to needy people who are 65 or over, blind, or disabled.

The social security program, created in 1935, began paying benefits in 1940. The SSA was set up in 1953 as part of the Department of Health, Education, and Welfare. It took over most social security functions of the former Federal Security Agency.

Critically reviewed by the SOCIAL SECURITY ADMINISTRATION

See also SOCIAL SECURITY; MEDICARE.

SOCIAL SETTLEMENT. See SETTLEMENT HOUSE.

SOCIAL STRATIFICATION. See SOCIAL CLASS.

SOCIAL STUDIES is the program of citizenship education provided by the elementary and secondary schools. The social studies program organizes the subject matter of the social sciences for presentation to children and young people. At the higher education levels, students generally study and specialize in one or more of the separate social sciences, such as history, geography, economics, political science, sociology, or anthropology. In the lower schools, particularly in the elementary grades, educators usually combine materials from these separate fields. Sometimes, scholars use the terms *social sciences* and *social studies* interchangeably.

In the Elementary Grades, a social studies course tries to help children understand and carry on the basic human activities: producing and exchanging goods and services, protecting and conserving life and resources, transporting goods and people, communicating facts and feelings, providing education and recreation, expressing spiritual and aesthetic impulses, and organizing and governing.

The social studies program also tries to develop competent membership in each of the communities of men: the family, the school, the neighborhood, the town or city, the state, the region, the nation, the region of nations, and the world. A pupil studies each of these.

A coordinated social studies program in the elementary school has a close relationship to history and values. Each of the communities of men has always carried on the basic human activities, but in different ways and at different times. The historical changes that have come about in the tools and techniques for carrying on these activities are important aspects of the social studies program. The values which a community holds affect the way in which people conduct these activities. For example, the Puritans placed great emphasis on orderliness, and this value pervaded most of their enterprises.

Subject matter drawn from the social sciences fills out the story of how men have carried on the basic human activities in various settings.

In the Secondary Schools, the study pattern usually shifts to a series of social science subjects taught separately. For example, schools may offer civics in grade 9, world history or world geography in grade 10, United States history in grade 11, and contemporary problems in grade 12. Many high schools also offer economics, anthropology, sociology, or other social sciences as electives. PAUL R. HANNA

Related Articles. See the separate articles in WORLD BOOK on each state, province, country, and continent. Other related articles include:

Anthropology	Conservation	History
Citizenship	Culture	Political Science
Civics	Economics	Social Science
Civilization	Family	Sociology
Communication	Geography	Transportation
Community	Government	World

SOCIAL SURVEY. See SOCIOLOGY (Surveying).

SOCIAL WAR. See ROMAN EMPIRE (A Century of Revolution).

SOCIAL WELFARE. See SOCIAL WORK; GREAT BRITAIN (The Welfare State).

SOCIAL WELFARE, NATIONAL CONFERENCE ON, promotes discussion of the problems and methods of practical human improvement. It has about 8,000 members, about 1,200 of them agencies or social-welfare organizations. It holds an annual forum and publishes the proceedings. It also publishes a quarterly *Conference Bulletin*. Headquarters are at 22 W. Gay Street, Columbus, Ohio 43215. Critically reviewed by the NATIONAL CONFERENCE ON SOCIAL WELFARE

SOCIAL WORK refers to the services of trained persons called *social workers* who help and guide individuals, families, or groups. Social workers may be connected with public or private agencies. They work in children's homes, churches, clinics, clubs, community centers, courts, employment offices, family-aid bureaus, hospitals, schools, and settlement houses. They participate in delinquency programs, craft and recreation projects, and youth services.

The term *social work* was first used in the early 1900's. In a broad sense, anyone who performs good works is doing social work. The roots of social work lie deep in mankind. The desire to help people and to share with those in need is the basis of all social work, professional and volunteer. The professional social worker is trained to help people through a scientific knowledge of human behavior and society. This training helps the social worker handle the many complex problems and situations of modern life.

The Need for Social Work

People vary in abilities and ambitions. They differ in their needs and in the circumstances in which they find themselves. The needs of people do not always balance with the means to obtain them. The young and the aged are less able to pay for what they need than are the middle-aged. The sick are less able to pay than the well, and the poor less able than those with average or high incomes. This relation of needs to means, where services are scarce, justifies thoughtful action in behalf of those in need.

The moral values and attitudes that underlie organized social work have changed in the past few decades. Originally, many people felt that every individual should be able to take care of himself. If an individual, except in extreme circumstances, did not work, make money, and get ahead, it was his own fault. He was scolded for his condition and given some charity. Charities were a type of "tax" levied by the poor on the rich, the nonworker on the worker, the weak on the strong, and the lawbreaker on the law-abiding.

This attitude began to change in the 1930's when it became clear that every family could not be expected to take care of itself in economic hard times. Government provided more aid for social work. People became interested in finding ways to prevent social problems from occurring. They began to feel that all citizens were entitled to minimum standards of health, decency, and opportunity, regardless of their economic means. They based their belief on a deepening recognition of the rights of individuals. They believed that such minimum standards were necessary for national security, progress, and well-being.

Since World War II, the public attitude toward social work has shifted from minimum standards of service to very favorable standards in health, education, recreation, and welfare. Individuals often turn to government agencies when their incomes do not permit a high level of social well-being. They may also organize into groups to provide the services they need, as, for example, a nursery school for which parents pay dues.

Professional Training

Throughout history, many men and women have worked to help those in need. Most of these people contributed their services on a voluntary basis. They did not receive any formal training to help prepare them for the work. They learned to deal with people and their problems in a trial-and-error fashion while on the job.

The problems of modern society became more complicated with the growth of population and industry, and the movement of people from rural areas to the cities. These new circumstances made it necessary to establish social agencies on a more organized basis and to employ full-time staffs. People soon realized that these agencies needed trained personnel in order to do the work effectively. The first schools of philanthropy, now known as *schools of social work*, were established in the 1900's to provide this training. The United States and Canada now have about 60 accredited schools of social work.

Schools of social work recognize at least five major areas of social work. These include: (1) case work, (2) group work, (3) area organization, (4) national programs and legislation, and (5) research. Each area has its own set of guiding values, its own body of facts, principles, and theories, and its own methods of operation. This does not mean that the areas are completely separate and distinct. All share a common body of values, knowledge, and practice that is the core of professional social work.

Case Work involves direct contacts between the social worker and individuals and families. It deals with problems of relations within the family, such as parent-child tensions; personal relations outside the family, such as relations with neighbors and friends; and various other activities, such as household management, health care, and public relief when it is needed.

As a student, the prospective case worker receives supervised field experience, and training in methods of work such as interviewing, motivating persons, budgeting, and the use of community resources.

Social Work Programs assist people in many ways. This social worker guides a youngster working on a handicraft project.

WORLD BOOK photo

Group Work refers to programs for groups of all ages. It includes activities in the arts, crafts, and recreation. The group worker tries to develop the individual capacities and to fulfill the needs of each member of the group. He also tries to interest the group in other community projects to develop civic responsibility.

The group worker's training includes the principles of group dynamics and planning, assessment of group activities, and leadership training. This training prepares the group worker to serve in social settlements, churches, schools, and institutions for the aged, delinquents, and the physically handicapped.

Area Work, or community organization, is an activity in social work that deals with area-wide efforts to plan programs, coordinate agencies and resources, and administer community health and welfare services. It includes working with community councils and councils of social agencies. Chief emphasis is placed on the training of local leaders. The social worker provides indirect leadership to help citizen groups work out their problems.

National Programs constantly increase in number and complexity. Keeping up to date on state and federal social programs requires a great deal of time. This special area of study provides important information to social workers in the other areas, so that they may direct their clients' activities to the proper channels. Such knowledge helps the individual obtain those benefits that are rightly his. Proper knowledge of existing legislation also helps to plan future developments in social legislation.

Research. Fact-finding forms a vital part of social work. Such surveys add to existing knowledge by systematic study. The everyday observations of the social worker are important. But this information must be analyzed and studied systematically to provide a complete picture of the goals and methods of the profession. Social work research centers on studies of service agencies and their programs, on persons as individuals and in groups, and on changing conditions and trends in society at large. Knowledge in social work depends also on the research in such other areas as sociology, psychology, and psychiatry.

Careers in Social Work

Social work is an area of great activity and growth. Many new specialties are developing to meet the problems created by social and technological changes in modern life. Many people now realize the valuable contribution that the social worker makes to the community. As a result, the demand for social services and for trained social workers has increased.

Most social workers deal directly with people. They try to help the individual work out his problems. They work with individuals, families, or groups. Social workers also administer various community programs. Some social workers devote their time to research.

Most social work is rather exacting in its demands, because the social worker must deal with people at their worst as well as at their best. Changes in individuals may be slow or none at all. The social worker must learn to take this in his stride. But the social worker gains much personal satisfaction from the knowledge that he is doing something basic and essential. He feels that he is helping individuals develop, and thus helping the community solve its problems.

The educational requirements for a professional social worker include a bachelor's degree and two years professional training leading to a master's degree in social work. The program includes class work and field work. Vocational information may be obtained from the Council on Social Work Education, 345 E. 46th Street, New York, N.Y. 10017. LLOYD ALLEN COOK

Related Articles in WORLD BOOK include:

ORGANIZATIONS

Big Brothers of America
Children, Societies for
Family Service, Association of America
Jewish Welfare Board, National
Junior Leagues
Public Welfare Association, American
Red Cross
Salvation Army, The
Social and Rehabilitation Service
Social Welfare, National Conference on
Social Workers, National Associations of
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OTHER RELATED ARTICLES

Addams, Jane
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Child Welfare
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Service Club
Settlement House
Wald, Lillian D.
Welfare

SOCIAL WORKERS, NATIONAL ASSOCIATION OF, is a professional organization devoted to the improvement of social work practices and standards. The organization works to improve the quality of social services to individuals, communities, and the nation. The association was formed in 1955 by the merger of seven organizations. It has 50,000 members in more than 170 chapters in the United States, Puerto Rico, and Europe. Its publications include two quarterly journals, *Social Work* and *Abstracts for Social Workers;* and *The Encyclopedia of Social Work.* It has headquarters at 1425 H Street NW, Washington, D.C. 20005.

Critically reviewed by the NATIONAL ASSOCIATION OF SOCIAL WORKERS

SOCIALISM is an economic system, a political movement, and a social theory. Most socialists believe that national or local governments, rather than individuals, should own a nation's resources and control their use. Socialism calls for public ownership of land, factories, and other basic means of production.

The idea of *collective ownership* (common ownership) of property dates at least from the time of ancient Greece. In the 300's B.C., the Greek philosopher Plato proposed that a ruling class own everything in common, putting the welfare of the state above all personal desires. Since ancient times, a number of groups have had some form of community ownership of property.

The word *socialism* was first used in the early 1800's. At that time, socialism meant opposition to the selfishness that some people thought was the root of any *capitalist,* or *free enterprise,* system. During the early 1800's, the Industrial Revolution in Western Europe caused severe social problems. For example, many factory owners made their employees work long hours at

Alfred G. Meyer, the contributor of this article, is Professor of Political Science at the University of Michigan.

low pay and under unhealthful conditions. Socialists claimed that public ownership or control of productive resources would assure fairer treatment for all. See INDUSTRIAL REVOLUTION (Life During the Industrial Revolution).

Today, socialists disagree on many important points. Some want a strong central government running the economy. Others favor as much local control as possible. Still others believe there should be no government in a socialist society. Some socialists argue that socialism can be achieved only through revolution and violence. Others believe that it must come gradually, within the framework of existing political institutions.

Most countries today have socialist political parties. Many nations have socialist governments, and almost all countries have adopted some of the ideas and methods that have been part of socialist programs. In addition, the countries in which Communist parties control the government are sometimes called *socialist*, but most socialists reject this use of the term.

This article describes what socialism is and how it developed. For more information on socialism and other economic and political institutions, see the WORLD BOOK articles on COMMUNISM; DEMOCRACY; ECONOMICS; FREE ENTERPRISE SYSTEM; and GOVERNMENT.

Socialism and Communism

The words *socialism* and *communism* once meant about the same thing—a society based on public ownership of the means of production. Today, people draw sharp distinctions between the two terms.

Members of Communist parties consider socialism as a stage in the development of Communist societies. During this stage, a Communist party is in power in a country, most private property has been eliminated, and the economy is run on the basis of a national production plan. However, the nation is not yet rich enough to give its citizens all the material benefits they need, and the government must *coerce* (force) people to work hard for little reward. In a later stage, the nation will be wealthy enough to satisfy everyone's economic wants. That stage is Communism. Communists claim that coercion by the government will disappear under Communism.

Democratic socialists—that is, socialists in non-Communist countries—do not accept the Communist definition of socialism. Most of them believe that some government coercion is necessary because some people must be forced to be good citizens. Democratic socialists reject most of the methods used by Communist parties, such as revolution and other forms of violence as means of gaining power. Democratic socialists also oppose dictatorial methods of running the state after they are in power. Unlike Communists, democratic socialists believe in democratic processes and do not wish to get rid of all opposition parties. They care more about the fair distribution of goods and services than about rapid economic growth. They also favor democratic methods for determining what is to be produced.

Goals and Methods of Socialism

Socialists claim that free enterprise systems are inefficient and wasteful. They believe that capitalism leads to such problems as unemployment, poverty, business cycles, and conflicts between workers and the owners of the means of production. To solve these problems, socialists believe that a nation's wealth must be distributed more equally and justly. They strongly oppose social inequality and discrimination. Socialists aim for a society based on cooperation and brotherhood rather than on competition and self-interest.

Socialism proposes to fulfill its aims by placing the major means of production in the hands of the people, either directly or through the government. Ownership may be by national or local government or by cooperatives. Many socialists favor a *mixed economy*—government ownership of basic industries and private ownership of many other businesses. The private businesses, however, would be regulated by the government.

Socialists believe that a country's resources should be used according to an overall economic plan formulated by manufacturers, farmers, workers, and government officials working together. By such planning, socialists hope to adjust production to the needs of the people. Although the forces of supply and demand may influence production and prices under the socialist economic plan, many decisions regarding how much to produce and what to charge will be made by political authorities.

Socialists disagree over how much wealth should be left in private hands and how to deprive the rich of their excess property. Many socialists call for redistribution of wealth through taxation. They favor laws to help the aged, the unemployed, the disabled and handicapped, widows, dependent children, and other people in need. Many socialists believe that the government should also provide free education and medical service to everyone and should help all citizens obtain safe and sanitary housing at rents they can afford.

Development of Socialism

Early Socialists. During the early 1800's, several writers and reformers criticized industrialism as the cause of great hardship and suffering among working people. Such men as Robert Owen of Great Britain and François Fourier and the Comte de Saint-Simon of France made various proposals for setting up communities with ideal social and economic conditions. Owen and followers of Fourier established short-lived cooperative settlements. These socialists were frequently called *utopians*. This term comes from the book *Utopia* (1516) by the English statesman Saint Thomas More. *Utopia* is an account of an ideal society that provides equality and justice for all.

Karl Marx, a German economist and social philosopher, became the most influential socialist of the 1800's. Marx's basic socialist ideas were first expressed in the *Communist Manifesto* (1848), which he wrote with his friend Friedrich Engels. Marx called his socialism *scientific socialism* to distinguish it from utopian socialism. He believed that all history is a series of struggles between the ruling and working classes. Marx taught that capitalism would be replaced by socialism. He predicted that the ruling class would be overthrown. The victorious working class would then set up a society based on common ownership of the means of production, not on economic privilege. For a fuller discussion of Marx's ideas, see MARX, KARL; and COMMUNISM (Marxism).

SOCIALISM

The International Socialist Movement. During the late 1800's, several socialist political parties were formed in Europe and North America. In time, these parties became united in an international organization with a single set of beliefs inspired by the writings of Marx. Between 1890 and 1914, the socialist movement grew strong, and socialist parties nearly won control of the government in several countries. But beneath the seeming strength, deep divisions existed. The movement included moderates, radicals, and revolutionaries. In addition, some socialist leaders rejected the doctrines of Marx. The international organization even included groups or parties that were non-Marxist. For example, the Fabian Society, a socialist group in Great Britain, derived its beliefs from Christian ideas and long-established traditions for achieving reforms.

After World War I began in 1914, the international socialist movement collapsed. Socialist leaders had to decide whether they were loyal to the movement or to their country, regardless of who governed it and how. Most socialist leaders decided to place patriotism above their socialist convictions.

Following the Russian revolution of 1917, revolutionary socialists founded new parties, which they called Communist parties. Since then, democratic socialists and Communists have become bitter enemies. Most socialists today are more critical of the writings of Marx than were early socialists. As a result, socialism can no longer be described as a Marxist *ideology* (set of doctrines), though many socialists consider Marx one of many important teachers.

In the United States, for various reasons, socialism has never been so strong as in Europe. In Europe, socialism was largely a working-class movement. But the labor movement began later in the United States and grew slowly. Many scholars believe that labor developed slowly in the United States because the frontier and the untapped wealth of the country provided greater opportunities—even for the poor—than Europe did. Other scholars believe that American ideas of freedom and individualism weakened the appeal of socialism. Some people think that socialism remained weak in the United States because a wide variety of socialist groups sprang up between the 1880's and World War I, and socialists could not develop a unified program.

The Socialist Party has been the most successful socialist political group in the United States. The party reached its greatest strength in 1912, when it had more than 118,000 dues-paying members. In the 1912 presidential election, the Socialist candidate, Eugene V. Debs, received almost 900,000 votes. In the 1920 election, Debs received about 920,000 votes. After Debs's death in 1926, Norman Thomas became the party's leading spokesman. He was the party's candidate in every presidential election from 1928 through 1948.

Since the early 1920's, Socialist strength has greatly declined. The Socialist vote fell to about 2,000 in the 1956 presidential election. Since then, the party has not nominated a candidate for President, but it continues to try to spread its ideas.

The United States has basically a free enterprise system, though it has adopted many ideas and methods that have been part of socialist programs. For example, the government regulates and controls many private businesses. It also has set up many social welfare programs to aid the needy, and a few public services are free to everyone. The government strives to maintain employment at as high a level as possible. The government also uses its strong taxing, spending, and credit powers in an attempt to achieve maximum employment, production, and incomes without large increases in prices. However, the United States has adopted far fewer socialist features than have most other industrialized countries.

Socialism Today. Most socialists are firmly committed to work within the framework of a country's constitution. They seek to cooperate with all parties and regard socialism as a spokesman for broad popular concerns, not just those of the workers. Many socialists do not insist on placing all major means of production under public ownership. They are content to regulate private business. Most socialists oppose Communism.

Many countries have socialist parties. In some countries, a socialist party runs the government. In other countries, socialists are members of a coalition government. Social-democratic parties have been in power for many years in Denmark, Norway, and Sweden. In Great Britain, the Labour Party, whose policies are based on socialist ideas, has formed several administrations since 1924. Socialist parties also rule many countries in Africa, the Middle East, and Southeast Asia. Other countries with strong socialist parties include Argentina, Australia, Canada, France, India, Israel, Italy, Japan, New Zealand, and West Germany.

No countries today are purely socialist. Even countries governed by Communist parties still have some free enterprise, though most resources are in public hands.

ALFRED G. MEYER

Related Articles in WORLD BOOK include:
Bebel, August
Berger, Victor L.
Cooperative
Debs, Eugene V.
Engels, Friedrich
Fabian Society
Fourier, François M. C.
International, The
Owen (family)
Proudhon, Pierre J.
Saint-Simon, Comte de
Thomas, Norman M.
Webb (family)

For a *Reading and Study Guide on Socialism*, see the RESEARCH GUIDE/INDEX, Volume 22.

SOCIALIZATION, in the behavioral sciences, refers to the complex process by which individuals come to learn and perform behavior expected of them by society. Socialization teaches habits, ideas, attitudes, and values. Behavioral scientists—anthropologists, psychologists, and sociologists—regard socialization as one of the principal ways by which societies perpetuate themselves. Through socialization, which is sometimes called *enculturation*, culture is transmitted from one generation to the next.

Learning plays an important part in socialization. A person must acquire a wide range of information and skills to participate in the activities of a family, a play group, a school group, a business, or a political system. Besides learning the rules and values of society, an individual must believe in them and support them. On the other hand, people need not accept all the values and rules of their elders. Selective acceptance and rejection account for major changes in social codes. But total rejection of earlier standards destroys social or-

ganization. Such rejection may have an unfortunate effect on some individuals, because all persons depend on others to a large degree.

Behavioral scientists study socialization because of three basic characteristics that are common to all human beings. First, human infants cannot live unaided and must depend entirely on others. Second, human beings—strictly speaking—do not have instincts and must learn most of the behavior necessary for survival. Third, because men lack instincts, they must learn to control their relations with one another by living according to shared values and roles.

The family plays a central role in the socialization of the child. From his family, the child learns such basic functions as speaking, toilet management, and eating properly. He also learns the basic values, beliefs, and goals of the family. Socialization is deliberate when individuals are told what to do or how to act. But much socialization is unconscious. For example, children learn many basic attitudes and values by observing other persons, especially their parents or older brothers or sisters.

In some societies, socialization takes place almost exclusively in infancy and early childhood. This occurs in most primitive societies and in those societies with rigid social systems and little change in technology. In modern societies, socialization begins in infancy and continues throughout a person's life. Other agencies, especially the school, have taken over some of the family's socialization functions. As an individual advances through successive stages of school, he continually discards some attitudes and roles and takes on new ones. Other important elements that influence social behavior include friends and co-workers, religious institutions, television, motion pictures, and various kinds of reading matter. WILBERT E. MOORE

See also SOCIAL ROLE; SOCIAL PSYCHOLOGY (Social Learning and Personality Development).

SOCIALIZED MEDICINE usually refers to compulsory health insurance in which the law compels citizens to join a government health program. It sometimes describes a system of health care in which a government owns and operates all medical and hospital services. The government employs all health personnel, including doctors, dentists, and nurses. Russia and other Communist nations have this type of health program.

More than 50 countries have government-sponsored health insurance. Usually, the people contribute either a flat sum or a percentage of their wages. Sometimes the employer matches this amount. Often, the government also makes a contribution. When a person needs medical care, the government uses the money collected to pay for the doctor, dental, hospital, or nursing bills. Some compulsory health programs provide eyeglasses, artificial limbs, false teeth, and other aids.

Under compulsory health insurance, hospitals may be privately owned. The doctors, nurses, and dentists are not necessarily hired by the government. Usually, the patient may select his own hospital and doctor.

Many persons oppose compulsory health insurance because they believe it restricts the freedom of the medical profession, results in inadequate medical care, and becomes the tool of politicians. But others argue that compulsory health insurance provides medical care for more people, and thereby improves the health of a nation. They also contend it keeps patients from worrying about medical costs. CLEMENT S. MIHANOVICH

See also MEDICARE; MEDICAID.

SOCIETY. See CULTURE; SOCIOLOGY.

SOCIETY FOR THE ADVANCEMENT OF EDUCATION was organized in 1939 to purchase and publish the journal *School & Society.* The journal publishes information on problems and trends in the field of education. The society has about 900 members. Its headquarters are at 1860 Broadway, New York, N.Y. 10023.

SOCIETY FOR THE PRESERVATION AND ENCOURAGEMENT OF BARBER SHOP QUARTET SINGING IN AMERICA. See BARBERSHOP QUARTET SINGING.

SOCIETY FOR THE PREVENTION OF CRUELTY TO ANIMALS (SPCA) is the name for many groups which do important work in preventing the mistreatment of animals. These anticruelty societies influence governments to pass laws providing for the punishment of persons who mistreat animals.

The first humane society was founded in 1824 in England. The first in the United States was the American Society for the Prevention of Cruelty to Animals (ASPCA), organized in New York by Henry Bergh and chartered by the state legislature in 1866. It is limited to that state.

Although there is no national organization, there are about 600 similar societies in the United States. One of the main functions of such societies is to enforce the laws by investigating cases of cruelty and by regular inspection of places where many animals are kept. Some societies, such as the ASPCA, maintain animal hospitals and shelters. The American Humane Education Society sponsors an annual Be Kind to Animals Week to promote better treatment of animals. JUNE ELIOT

SOCIETY ISLANDS is a group of islands in the Pacific Ocean. The islands lie slightly northeast of the Cook Islands, about 4,200 miles (6,760 kilometers) southwest of San Francisco. Samuel Wallis claimed the islands for Great Britain in 1767. But Louis Antoine de Bougainville claimed them for France in 1768. The group became a French protectorate in 1842, and a colony in 1880.

The Society Islands group consists of 14 islands. Tahiti and Raiatea are the largest islands of the group. The Society Islands cover an area of 646 square miles (1,673 square kilometers), and have a population of about 82,000. For the location of the Society Islands, see PACIFIC ISLANDS (color map).

Ancient volcanoes on the Society Islands form many high peaks, making the land rough and mountainous. Some of the islands are low atolls, and are used as fishing centers. The capital of the island group is the busy seaport of Papeete, on Tahiti.

The people of the islands are Polynesians. Many of them fish and dive for pearls. EDWIN H. BRYAN, JR.

See also TAHITI.

SOCIETY OF FRIENDS. See QUAKERS.

SOCIETY OF JESUS. See JESUITS.

SOCIETY OF THE CINCINNATI. See CINCINNATI, SOCIETY OF THE.

SOCIETY OF THE SACRED HEART OF JESUS. See SACRED HEART OF JESUS, SOCIETY OF THE.

SOCIODRAMA. See ROLE PLAYING.

A Study in Sociology

After the State of Israel was established in 1948, thousands of immigrants began pouring into Israel from countries throughout the world. Sociologists worked with government officials in planning communities and teaching people of various backgrounds to live and work together. As the communities grew, the sociologists studied them to see how the people were adjusting to their surroundings. A typical Israeli settlement is Kiryat Gat, in the southwest. Its residents came from more than 50 countries. Many had no education at all. Few could speak Hebrew, Israel's national language. All had to learn a new way of life in an unfamiliar land.

Leni Sonnenfeld, Pix

Community Life in Kiryat Gat was carefully planned so that the people would quickly learn to know and trust one another. Villages were built around a main community center. Families of similar national backgrounds live close to each other in the villages. But all the people mingle as they shop, work, and study in the common center. Social workers make house calls on every family to discuss community affairs and help solve problems that arise.

SOCIOLOGY, *so see AHL oh jee,* is the study of human relationships. Sociologists try to find out how people live and work together. They study what happens when people take jobs, get married, join organizations, or deal with each other in countless other ways.

Sociology adds to man's knowledge of his society. Sociologists try to learn the causes of individual or group problems. After sociologists have learned the causes of social problems, they try to find ways of solving the difficulties. They also try to predict where similar problems will arise.

The sociologist uses scientific methods to study human behavior. Therefore, sociology is classified as a behavioral or social science, along with history, economics, political science, psychology, and anthropology.

The Main Divisions of Sociology

Sociologists use different methods to divide or classify the subjects they study. But the field may be divided into six main areas: (1) general sociology, (2) social psychology, (3) demography, (4) the community, (5) social organization, and (6) social change.

General Sociology studies the ways people associate with one another in groups of all kinds and sizes. Such groups include the family, the church, the school, labor unions, trade associations, and athletic teams. The most general group of all is a *society* (all the people who have any sort of contact with each other and have common traditions and history). The people of your hometown make up a society. All the people of the United States make up a larger society. The people of the

This article was contributed by Arnold M. Rose, former Professor of Sociology at the University of Minnesota.

SOCIOLOGICAL TERMS

Case Study is a research method in which a person or group is studied in detail.

Caste is a class or group of people distinguished from other members of a society by their birth, marriage, or occupation. See CASTE.

Class refers to a social group whose members have nearly the same possessions and characteristics valued by a culture.

Culture includes all the attitudes, possessions, and ways of life of a group of people. See CULTURE.

Disorganization refers to the state of a person or group that violates social rules.

Ethnocentrism is a belief in the superiority of one's own culture. This belief involves judging other individuals and groups by the standards of one's own group. See ETHNOCENTRISM.

Folkway is a custom or habit commonly followed by the members of a society. See FOLKWAY.

Group is a number of persons who have some customs, standards, or purposes in common.

Institution is a social organization or activity that uses a set of customs to achieve a goal.

Interaction means contact or movement by persons or groups that affects other persons or groups.

Mobility, or **Social Mobility,** usually refers to the movement of a person or group from one class or social group to another.

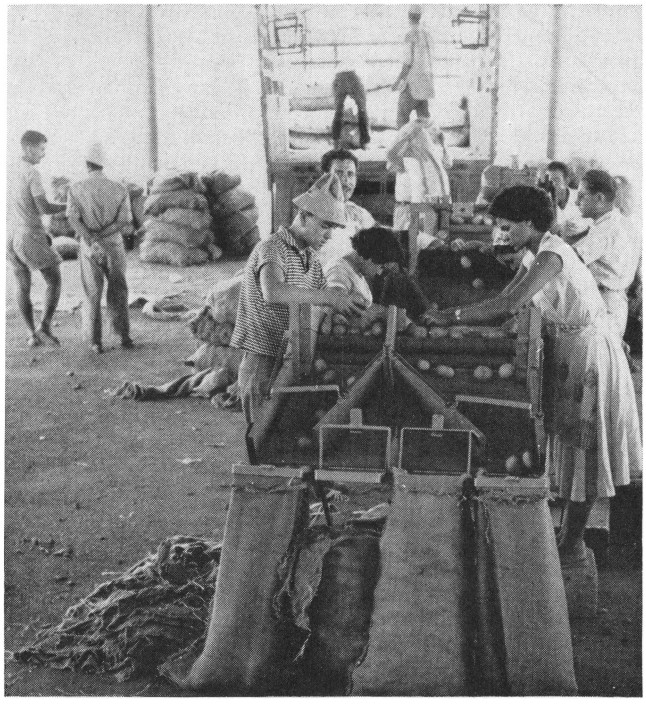
Mores are important customs that a society considers essential to its organization and welfare. See MORES.

Personality is the sum total of everything a person is and does. See PERSONALITY.

Prejudice is an idea formed without considering all the facts. Prejudice usually refers to unfavorable opinions toward racial, religious, or minority groups. See PREJUDICE.

Role refers to the actions that an individual in a group is expected to perform.

Society is a group of people who have direct or indirect communication with one another and share a culture.



Leni Sonnenfeld, Pix

Work and Education in the community of Kiryat Gat bring together adults and children from many lands. Settlers may choose the kind of work they want to do. Experts teach them how to use tools and equipment. The community's school enrollments are set up so that each school includes children from several villages.

United States, Canada, and Western Europe together make up an even larger society.

On the broadest scale, general sociology studies a society's *culture* (attitudes, possessions, and ways of life). Such ideas and attitudes enable people to live together in a society without making deliberate agreements whenever they come in contact with each other. For example, we seldom bump into people walking toward us on a sidewalk. We have a common understanding that we should move to the right to avoid them.

Individuals can form groups only by *communicating* (exchanging ideas and information). For this reason, sociologists believe that communication is the most important group activity. They study how people communicate in face-to-face conversation or by such means as letters, radio, television, and newspapers.

General sociology also studies such group activities as *cooperation* (the ways people work together) and *conflict* (the ways people resist each other).

Social Psychology studies the ways society affects a person's behavior and personality. A person belongs to many groups in a society. Each group has somewhat different standards of behavior. Generally, these standards set limits on the range of behavior. But a person often must decide how he should act within these limits. Social psychology studies the person's actions as related to the standards set by groups and society.

Three areas of study are especially important in social psychology: (1) the *processes* by which a person learns how he is expected to act in the various groups to which he belongs, (2) the *roles* (actions) he is expected to perform in society, and (3) the *models* (individuals) a person chooses to imitate in forming his behavior.

Demography studies changes, movements, and distribution of populations. Demography is also concerned with the sizes of populations, and with the groups that make up these populations.

As the population of a society increases, decreases, or remains the same, it can influence the society in several ways. It may change the members' outlook on life. It may affect the stability of the culture. Or it may affect the society's relationships with other societies.

The sociologist studies the *distribution of population* to learn how it affects relations between societies or groups. Demographic studies help the sociologist learn how *population density* (the number of persons per square mile) makes one society different from another.

Demographic information is also useful in many other ways. The sociologist may use it to show how different communities have different needs. One community may have an unusually high number of old people. The needs of such a community differ from those of a community of younger people. Demographic studies may show why a population is growing or decreasing. A population grows through births and immigration. A population decreases because of deaths and emigration.

The Community. The study of the community refers, basically, to the relationship between man and his environment. Sociologists study the community to learn how people adjust to the geographical areas or neighborhoods in which they live. For example, facts about man's environment may be used to explain why people in a certain area form particular groups.

Two types of communities have especial interest for the sociologist. In *urban sociology*, he studies city communities. For example, he may try to find out why some neighborhoods grow and change while others decline or remain the same. In *rural sociology*, the sociologist studies farm or small town communities. For example, he may try to find out why people living in rural areas

form communities in certain places and not in others.

Social Organization is the study of institutions. Sociologists define an *institution* as a social organization or activity that uses a set of customs to accomplish a specific purpose. These customs are always closely related. Most of the chief institutions in a society are connected with the family, the economy, the school, the church, and the government. Family institutions include marriage and parenthood. Government institutions include elections, laws, and the jury system.

Sociologists study institutions to learn (1) why they were established, (2) how they function, (3) how persons carry out their roles in institutions, and (4) how institutions serve the needs of individuals.

Social Change may be regarded as an essential part of all the fields of sociology. But many sociologists believe it deserves special attention. In speaking of change, a sociologist usually refers to basic forces that cause social change. In particular, he studies social changes caused by (1) inventions, (2) the spread of culture, (3) culture conflicts, (4) fashions, (5) social movements, and (6) war and revolution.

Sociologists believe some changes help men form a better or more efficient society. For example, a change in fashions may produce more comfortable clothing. But change also can lead to difficulty or unhappiness for many people, and may create *social problems*. Such problems include juvenile delinquency, crime, divorce, alcoholism, desertion, prejudice, slums, unemployment, and corruption in government. See SOCIAL CHANGE.

How a Sociologist Works

A sociologist begins most projects with an idea or a theory. For example, he may want to show that a new college in a small town makes the townspeople more aware of the benefits of higher education. He has two main tasks: (1) *surveying* (collecting information), and (2) *evaluating* (using the data to reach a conclusion).

Surveying. The sociologist may conduct his own interviews or research projects to obtain information. Or he may use sources of information provided by the society or group being surveyed.

In studying small-town attitudes toward higher education, the sociologist would probably begin surveying before the college is built. He would try to find out what people in the town think of college education. After the school has operated for some time, he would conduct further research. He might use letters, diaries, or other documents to show how particular townspeople have changed their attitudes. The second survey could indicate that book circulation from the town library has increased greatly. Perhaps interviews show that more young people became interested in a college education after the school was built.

In conducting his own surveys in any field, a sociologist can use many different techniques. He could interview individuals or whole groups. He might ask only a few questions, or he could make a wide variety of inquiries. In studying an institution, he would probably observe certain phases of its operations. To learn how an organization works, he could attend its meetings.

Societies and groups provide many kinds of official and unofficial sources of information. One official source in the United States is the national census taken every 10 years. Other government reports are also useful. In industrial research, the sociologist uses such sources as personnel records. In studying crime, he can examine records of arrests, convictions, and imprisonment.

Evaluating. The sociologist might collect hundreds, or even thousands, of facts and opinions. Then he must decide what all this information means. He must also state his conclusion.

Comparison of data is a basic process in most sociological research. The sociologist may compare earlier information with later findings, as in the project on college education. Or he might compare his facts with those gathered by other researchers. He could observe two groups and compare the different actions of the members of each group.

The sociologist usually expresses his conclusion as a general statement. In the study of attitudes toward college education, the sociologist may conclude that the college raised the cultural level of the town. The college aroused the interest of the townspeople. It provided a greater opportunity for young people in the region to earn college degrees. Perhaps the sociologist would predict that other towns would also benefit if they could attract colleges.

The Development of Sociology

Beginnings. Auguste Comte (1798-1857), a French philosopher, gave sociology its name. He combined the Latin word *socius* (meaning relationship) and the Greek word *logos* (meaning study). In his book *The Course of Positive Philosophy* (1830-1842), Comte declared that sociology would explain man to himself.

Interest in sociology spread rapidly. Fréderic Le Play (1806-1882) of France developed the *case study* method of research. He studied a single person or group in great detail. In England, Herbert Spencer (1820-1903) collected information from travelers and missionaries. His *Principles of Sociology* (1882) tried to show that all human societies develop, change, and grow in the same ways. An American, Lester Ward (1841-1913), declared in *Dynamic Sociology* (1883) that man could improve society after learning more about human behavior.

Sociology Becomes a Science. During the 1800's and early 1900's, physical sciences such as chemistry and physics made great progress. Many sociologists decided that sociology should also be recognized as a science. But they had difficulties because they were trying to measure human behavior. They could not conduct experiments as chemists could. They could not measure social events exactly because they could not control the conditions that influenced these events.

Émile Durkheim (1858-1917) of France published the first truly scientific study in the field of sociology. In this work, *Le Suicide* (1897), Durkheim investigated the causes of suicide. He presented theories about these causes and tried to test them scientifically. To do this, he obtained data from all countries that had statistics on suicide. Soon sociologists in Europe, China, India, and the United States made similar studies of cultural contacts, religion, and other subjects.

Modern Sociology. After World War I, a number of "schools" of sociology developed. They differed both on the methods sociologists should use, and on the purposes of sociology. Leading theorists included the Ital-

ian Vilfredo Pareto (1848-1923), the author of *Mind and Society* (1916), and the German Max Weber (1864-1920).

American sociologists took the lead in developing new ideas. Gradually, many turned away from social problems and concentrated more on normal aspects of human society. Three major trends in sociology developed.

One group of sociologists called for emphasis on collecting facts. Leaders of this group were William F. Ogburn (1886-1959) of the University of Chicago and F. Stuart Chapin (1888-) of the University of Minnesota. Ogburn and Chapin thought sociologists should use the research methods of other sciences to gather facts. They emphasized the use of statistics.

A second group of sociologists stressed the necessity of finding out how individuals interpreted social facts. To obtain information, they often studied personal documents such as letters and diaries. The leaders of this group included W. I. Thomas (1863-1947), Robert E. Park (1864-1944), and Ernest W. Burgess (1886-1966), all of the University of Chicago.

A third group believed that the various parts of a society fitted together and functioned to maintain the stability of the society. These men followed the ideas of Talcott Parsons (1902-) of Harvard University. Pitirim A. Sorokin (1889-1968), also of Harvard, was another leading sociologist who believed that different parts of society worked together. Sorokin's books include *Social Mobility* (1927) and *Social and Cultural Dynamics* (1937-1941).

During the 1950's and 1960's, American sociologists specialized more and more. They published many books and articles. Some writers not originally trained in sociology wrote popular books on sociological subjects. For example, *The Organization Man* (1957), by William H. Whyte (1917-), describes how working for large corporations affects individuals. *Future Shock* (1970), by Alvin Toffler (1928-), analyzes the effects of rapid change on modern and future society.

Careers in Sociology

Sociology offers a variety of career opportunities. They include teaching, research, and social work with governmental or private agencies. Usually, advanced study is necessary for men or women who want to work in sociology. But people with a bachelor's degree in sociology may find employment as interviewers or research assistants.

Sociology courses are usually offered as part of a liberal arts curriculum that includes such courses as history, literature, and philosophy. Students who find general courses in sociology interesting may take courses in special fields such as social problems, the family, or social planning. At the same time, they can study anthropology, biology, government, psychology, and other related subjects. Many sociology students attend meetings of the American Sociological Association, the Rural Sociological Society, or the Society for the Study of Social Problems. In addition to books, the student can read professional journals such as the *American Journal of Sociology* and the *American Sociological Review*.

College graduates who major in sociology sometimes find teaching careers in adult education. For example, some may teach race relations to policemen. Others teach human relations to management and union officials in business firms. College teachers of sociology need a Master of Arts (M.A.) or a Doctor of Philosophy (Ph.D.) degree. Most jobs for sociologists in industry and government also require advanced degrees.

Sociological research is an increasingly broad field. In the U.S. government, the Departments of Agriculture and the Interior employ specialists on communities. The Department of Health, Education, and Welfare has sociologists who study such subjects as juvenile delinquency, problems of the aged, and mental and physical illness. State governments hire sociologists to work primarily in the fields of crime and juvenile delinquency.

Sociologists in business and industry study public relations, personnel counseling, public attitudes, and labor problems. One large mail order company has sociologists who help decide which customers make good credit risks. In associations or other private groups, the sociologist might study propaganda, health and disease, housing needs, consumer relations, city planning, and other problems.

Many organizations and publications offer information on careers in sociology. The *Occupational Outlook Handbook*, which is issued each year by the U.S. Department of Labor, provides data on job opportunities in sociology as well as in other professions. Information may also be obtained from the American Sociological Association, 1722 N Street NW, Washington, D.C. 20036.

ARNOLD M. ROSE

Related Articles. For social workers and organizations, see the Related Articles at the end of SOCIAL WORK. See also the following:

SOCIOLOGISTS

Balch, Emily G.
Du Bois, W. E. B.
Frazier, E. Franklin
Johnson, Charles Spurgeon
Myrdal, Gunnar
Pareto, Vilfredo
Spencer, Herbert
Sumner, William G.
Weber, Max

RELATED STUDIES

Anthropology
Criminology
Demography
Ecology
Psychology
Social Psychology
Social Science
Social Work

OTHER RELATED ARTICLES

Alienation
Assimilation
Authority
Behavior
City
Civil Disobedience
Community
Crime
Cultural Deprivation
Cultural Lag
Culture
Custom
Family
Folkway
Group Dynamics
Hospital
Human Relations
Juvenile Court
Juvenile Delinquency
Middle Class
Minority Group
Mores
Orphanage
Population
Poverty
Power (social)
Prejudice
Public Opinion
Public Opinion Poll
Research
Riot
Segregation
Social Change
Social Class
Social Role
Socialization
Statistics
Unemployment
Vital Statistics

SOCRATES

SOCRATES, *SAHK ruh teez* (469?-399 B.C.), was a Greek philosopher and teacher. His noble life and courageous death, together with his teachings, have made him one of the most admired figures in history. He believed that man's nature leads him to act correctly and in agreement with knowledge. Socrates felt that man's evil and wrong actions arise from ignorance and the failure to investigate why people act as they do. Socrates is credited with saying "the unexamined life is not worth living" and "no man knowingly does evil." Socrates devoted himself completely to seeking truth and goodness.

Socrates' Life. Socrates wrote nothing of his own. Most of our information about his life and teachings comes from *Memorabilia* and *Symposium* by the historian Xenophon; dialogues by the philosopher Plato; *Clouds*, a comedy by Aristophanes; and writings by the philosopher Aristotle. Xenophon and Plato were Socrates' pupils, and Aristotle was a pupil of Plato's. Aristophanes was a leading playwright in Socrates' time.

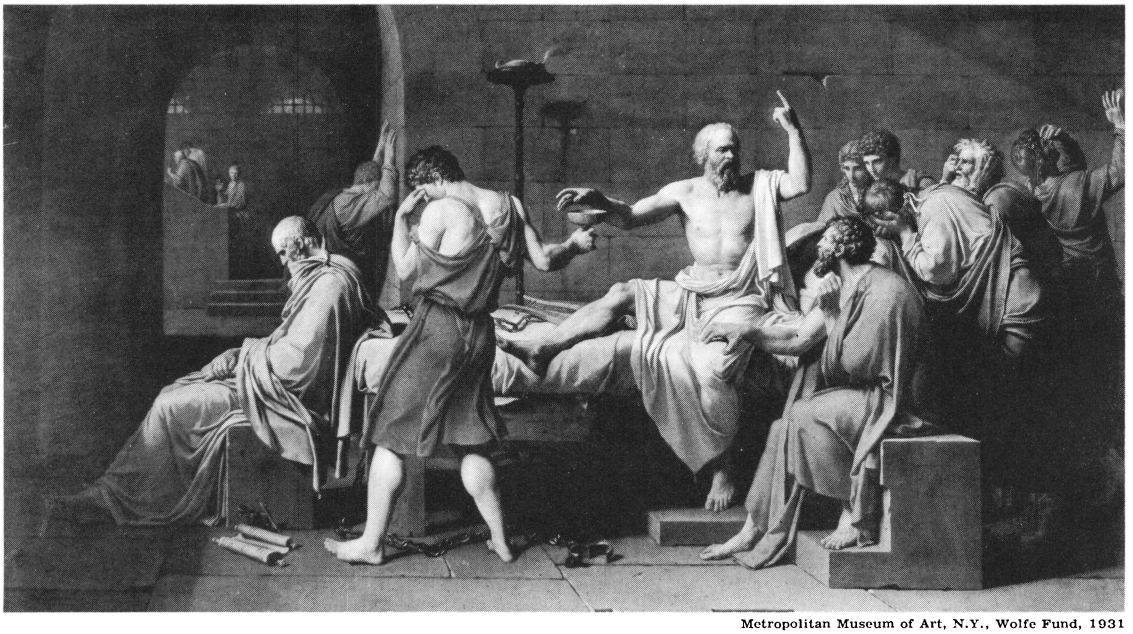
According to Xenophon, Socrates was a highly respected teacher chiefly interested in helping men become good. Plato's dialogues tell us that Socrates cared not only about ethics, but also about logic and a theory of *forms*. This theory tried to identify the quality in an object or idea that remains constant and unchangeable. Plato's dialogues contain the most probable account of Socrates' life and teachings. Aristotle seemed to agree generally with Plato's view of Socrates. However, Aristotle claimed that the theory of forms was more characteristic of Plato's philosophy than that of Socrates. In Aristophanes' *Clouds*, Socrates appears as a bumbling, foolish man who supports fantastic theories.

Socrates was born and lived in Athens. He dressed simply and was known for moderation in eating and drinking. He was married to Xanthippe, who, according to tradition, was ill-tempered and difficult to live with. They probably had at least two children.

Socrates taught in the streets, market place, and gymnasiums. He taught by questioning his listeners, and showing them how inadequate their answers were. Socrates had an enthusiastic following among the young men of Athens, but the general public mistrusted him because of his unorthodox views on religion and his disregard of public opinion.

Inevitably, Socrates made enemies among influential Athenians. He was brought to trial, charged with corrupting the young and showing disrespect for religious traditions. Socrates defended himself by stating that clear knowledge of the truth is essential for the correct conduct of life. Action, he said, equals knowledge. Thus, virtue can be taught because correct action involves thought. Socrates implied that rulers should be men who know how to rule—not necessarily those who have been elected. Socrates may have appeared dangerous to Athenian democracy, but what he defended were the foundations of that democracy. Plato described Socrates' defense in his dialogue, the *Apology*.

The jury found Socrates guilty and sentenced him to death. The jury may have given Socrates the severe sentence because it resented the unbending pride with which he conducted his defense. He refused several opportunities to escape from prison, and carried out the sentence by calmly drinking a cup of hemlock poison. A moving account of Socrates' death appears in Plato's *Phaedo*.



Metropolitan Museum of Art, N.Y., Wolfe Fund, 1931

Socrates Drinks the Cup of Hemlock to carry out the sentence of death imposed on him by the rulers of ancient Athens. This painting, *Death of Socrates* (1787) by Jacques Louis David, shows Socrates' followers in great despair. Socrates made a toast to the gods and drank the bitter poison. He met death with the same calm and self-control with which he had lived.

The Socratic Method. Socrates introduced the idea of *universal* (standard) definitions. He believed that although individual men or things vary and are constructed differently, the definitions of how they are similar or vary remain constant. For example, individual dogs differ in shape, color, and size. Yet there are some common characteristics by which we identify these animals as dogs, not as cats or camels. These common characteristics are the universal, to which man must turn when he judges anything.

Socrates believed that the correct method of discovering the common characteristics was by *inductive* means—that is, by reasoning from particular facts to a general idea. This process took the form of *dialectic* (philosophic) conversation, which became known as the *Socratic method.* Two or more men would begin a discussion with the assumption that each knew the definition of some key term. The conversation first showed that their assumptions were different, and then that the assumptions were inadequate to claim true knowledge. In this way, the men proceeded from less adequate to more adequate definitions. They also progressed from definitions that applied to only a few particular examples to a universal definition that applied to all examples. Although the men often reached no satisfactory conclusion, their goal was always the same —to gain a true and universal definition.

The Socratic method tended to expose men's ignorance. It showed that many things they assumed to be true were false. Socrates also used *irony* to expose men's ignorance of key concepts—that is, he claimed to differ from other men only in knowing that he was ignorant. Socrates' insistence on his ignorance reminded others of their own ignorance. J. L. SAUNDERS

For a *Reading and Study Guide on Socrates*, see the RESEARCH GUIDE/INDEX, Volume 22.

SOD HOUSE is a house with walls built of sod or turf in horizontal layers. Sod houses were constructed by early settlers on open plains where there were no trees to supply lumber. For a description of sod houses and how they were built, see WESTERN FRONTIER LIFE (Life in the Country); NEBRASKA (Territorial Days; picture).

SODA is the common name for a group of compounds that contain sodium. These sodium compounds are manufactured from common salt (NaCl), which is made up of sodium and chlorine. See SODIUM.

One common sodium compound is *sodium carbonate* (Na_2CO_3), known as *sal soda*, *washing soda*, and *soda ash*. It comes in crystals or white powder and has a strong alkaline reaction. This means that it neutralizes acids. Sodium carbonate is used in the manufacture of glass, soap, and paper. It is also used as a disinfectant, a cleaning agent, and a water softener.

Sodium bicarbonate ($NaHCO_3$) is a popular soda used in cooking and in medicines. It is also known as *baking soda* or *saleratus*. Baking powder contains sodium bicarbonate, which acts as a leavening agent because it causes bread, biscuits, or pastries to rise in baking. Seidlitz powders also contain sodium bicarbonate. They relieve excess stomach acid. See BAKING POWDER.

Sodium hydroxide (NaOH) is a sodium compound known as *caustic soda*. It is used in the making of hard soap, paper, and dyestuffs. It is also used in making bleaching compounds and in refining petroleum.

See also GLASS (Recipes); LEBLANC, NICOLAS.

SODA WATER. See SOFT DRINK.

SODDY, FREDERICK (1877-1956), was a British chemist who worked on atomic structure. He received the 1921 Nobel prize in chemistry for his research. He and Ernest Rutherford showed that radium breaks down by itself and gives off electrons, helium nuclei, and gamma rays, which are like X rays. Soddy gave the name *isotopes* to atoms of the same element which have different weights (see ISOTOPE). He was born in Eastbourne, Sussex, and studied at Oxford University. He also taught at Oxford. HENRY M. LEICESTER

Brown Bros.

Frederick Soddy

SÖDERBLOM, *SUH der bloom*, **NATHAN** (1866-1931), a Swedish archbishop and professor, was a leader of the ecumenical movement among the churches of the world. He won the 1930 Nobel peace prize for his work for war relief and peace during and after World War I. Söderblom was born in Trönö, near Uppsala, Sweden. He was educated at the University of Uppsala. In 1901, he became a professor in Uppsala, and in 1912, in Leipzig, Germany. He became archbishop of the Church of Sweden (Lutheran) in 1914. L. J. TRINTERUD

SODIUM is a silvery-white metallic element that has many important uses. It is a soft metal, and can easily be molded or cut with a knife. Sodium belongs to a group of chemical elements called the *alkali metals*.

Where Sodium Is Found. Sodium is the sixth most common chemical element in the earth's crust. It makes up about 2.8 per cent of the crust. Sodium never occurs *pure*—that is, as a separate element—in nature. It combines with many other elements, forming *compounds*. To obtain pure sodium, the metal must be *extracted* (removed) from its compounds.

One of the most familiar sodium compounds is *sodium chloride*, which is common table salt. Sodium chloride can be found in dry lake beds, underground, and in seawater. Countries with the largest deposits of sodium chloride include China, France, Great Britain, India, Russia, the United States, and West Germany.

Such minerals as borax and cryolite contain sodium. Many plants and the bodies of animals contain small amounts of sodium salts. The human body must have a certain amount of sodium for the cells to live and work.

Uses. Sodium compounds have many uses in industry, medicine, agriculture, and photography. Manufacturers use *sodium borate* (borax) in making ceramics, soaps, water softeners, and many other products (see BORAX). *Sodium hydroxide* (caustic soda) is an important industrial alkali used in refining petroleum and in making paper, soaps, and textiles. A lead-sodium *alloy* (combination of metals) produces tetraethyl lead, a gasoline compound that improves the performance of automobile engines. *Sodium carbonate* (soda ash or washing soda) is used in the manufacture of *sodium bicarbonate* (baking soda). Many people take sodium bicarbonate to relieve an overly acid stomach. Doctors sometimes

E. I. du Pont de Nemours & Company

Pure Sodium must be stored and shipped in airtight, watertight containers because sodium quickly unites with other elements.

prescribe *sodium bromide* as a sedative for tense patients. *Sodium nitrate* (Chile saltpeter) is a valuable fertilizer. Photographers use *sodium thiosulfate* (hypo) to fix photographic images on paper.

Pure sodium also has industrial uses. Some nuclear power plants use it in liquid form to cool atomic reactors. A few electric power cables have been made of pure sodium metal. Special insulation around the sodium keeps it from combining with air, water, or other substances.

Extracting Sodium. In 1807, the English chemist Sir Humphry Davy became the first man to obtain pure sodium. He used electricity to extract the metal from sodium hydroxide. Manufacturers still use electricity to obtain sodium. The process is called *electrolysis*. In this process, an electric current is passed through a molten sodium compound, such as sodium chloride. The current separates the compound into chlorine gas and sodium metal. See ELECTROLYSIS.

Chemical Properties. Pure sodium is extremely active chemically. Sodium immediately combines with oxygen when it is exposed to the air. As a result, the element loses its shiny appearance and becomes dull. Sodium's bright surface can be seen only after it has been newly cut or extracted.

Sodium weighs less than water. It *decomposes* (breaks up) water, producing hydrogen gas and sodium hydroxide. This chemical reaction is very violent. It produces much heat that often causes the hydrogen to burst into flame.

The element also reacts quickly with such other nonmetals as chlorine and fluorine, and it forms alloys with many metals. Liquid ammonia dissolves sodium, forming a dark-blue solution. A common test for determining whether a material contains sodium is to hold it in a flame. If sodium is present, the flame will be bright yellow.

Sodium must be handled and stored with extreme care. In laboratories, small amounts are stored under kerosene in airtight bottles. The kerosene prevents air or moisture from reaching the metal. Large quantities of sodium in brick form are stored and shipped in airtight, moisture-free barrels. Sodium is also shipped in sealed tank cars. The metal is melted and poured into the tanks. The sodium hardens during shipping, and must be melted again before it can be removed.

Sodium has the chemical symbol Na. Its atomic number is 11, and its atomic weight is 22.9898. The melting point of sodium is 97.8° C (208° F.), and its boiling point is 892° C (1638° F.). OTTO THEODOR BENFEY

See also ALKALI; SALT; SALT, CHEMICAL; SALTPETER; SODA.

SODIUM BICARBONATE. See BICARBONATE OF SODA.

SODIUM BORATE. See BORAX.

SODIUM CARBONATE. See SODA; CARBONATE.

SODIUM CHLORIDE. See CHLORIDE; SALT.

SODIUM HYDROXIDE. See CAUSTIC; LYE; SODA.

SODIUM METASILICATE. See WATER GLASS.

SODIUM NITRATE. See SALTPETER; NITRATE.

SODIUM PENTOTHAL is a drug used to produce sleep during surgery and to help patients discuss their problems during psychiatric treatment. Sodium pentothal has been called a "truth serum" because many people talk less guardedly after taking it. Sodium pentothal is also called *sodium thiopental* and *thiopental sodium*. *Pentothal Sodium* is a trade name for the drug.

Physicians use large doses of sodium pentothal to produce deep sleep during surgery. Smaller doses may be used to bring on light sleep before surgery to relieve the patient's anxiety. Psychiatrists sometimes give patients even smaller doses of sodium pentothal. Such doses do not produce sleep. But they enable many people to discuss their thoughts and emotions more freely than might otherwise be possible.

Sometimes a physician may be asked to administer sodium pentothal to a person in an effort to obtain information for a police investigation. But the drug cannot be used legally without the person's consent. Courts seldom allow information to be used as evidence if it was obtained after the administration of sodium pentothal. Some people can lie even after receiving the drug. Others tell falsehoods that they believe are true. DONALD J. WOLK

SODIUM SULFATE. See SALT, CHEMICAL.

SODIUM TETRABORATE. See BORAX.

SODIUM THIOSULFATE. See HYPO.

SODIUM VAPOR LAMP. See LIGHTING (Lighting Devices).

SODOM, *SAHD um,* was one of the ancient cities on the plain around the Dead Sea. It is believed that the place where the city stood now lies beneath the waters near the south end of the sea. During early Bible times, the region was so fertile it was compared to the "garden of the Lord" (Gen. 13:10). But later, according to the Old Testament, God destroyed Sodom and the neighboring city of Gomorrah, because the people were wicked.

The Old Testament also tells how Lot, the nephew of Abraham, escaped from Sodom just before it was destroyed. Lot and his wife had been warned by two angels to flee the city and not look back. Lot obeyed, but his wife took a last glance at Sodom. She was immediately turned into a pillar of salt as punishment for her disobedience. WILLIAM A. IRWIN

See also LOT.

SODOM, APPLE OF. See APPLE OF SODOM.

SOFIA, *SOH fee uh* (pop. 800,953; met. area 894,487), is Bulgaria's capital and largest city. It is also the chief trading center of Bulgaria. Sofia stands on a high

plain between the Vitosha Mountains and the main Balkan mountain ranges. It is about 180 miles (290 kilometers) southwest of Bucharest. The city's many factories produce such items as machinery, textiles, food products, and electrical equipment. For location, see BULGARIA (color map).

Important buildings include the former royal palace, the Cathedral of Saint Alexander, the House of Parliament, the opera house, Communist Party headquarters, and the Kliment Ochridski University (formerly Sofia University), founded in 1888.

Early Sofia was a Roman city. The Huns invaded the city during the 400's, and the Bulgarians occupied it 400 years later. Sofia was under Turkish rule from 1382 to 1878. IRWIN T. SANDERS

SOFT-COATED WHEATEN TERRIER is a breed of dog that originated in Ireland. Irish farmers used it to drive cattle, to guard houses and barns, and to kill rats and other pests. This terrier is related to the Irish and Kerry blue terriers.

Soft-coated wheaten terrier puppies are dark brown or brownish-red. The adults have a rich wheat-colored coat of soft, wavy hair. The dog's shaggy hair nearly covers its eyes. Most of these terriers have *docked* (cropped) tails. The dogs stand about 19 inches (48 centimeters) high and weigh from 35 to 45 pounds (16 to 20 kilograms). JOAN MCDONALD BREARLEY

Leprecaun from Juanita Wurzburger

The Soft-Coated Wheaten Terrier Comes from Ireland.

SOFT DRINK has become as typically American as the hot dog and chewing gum. Soft drinks are called *soft* to distinguish them from *hard* (alcoholic) beverages. Soft drinks are often called *pop*, because of the noise they made when the caps were removed from the bottles. Caps used since the mid-1890's do not make this noise when they are removed.

Ingredients. Almost all soft drinks consist of soda water, flavorings, and sugar. A small part of the flavoring of the most popular soft drinks in the United States comes from the extract of the kola, or cola, nut (see KOLA NUT). Soft drink manufacturers also use various fruit flavorings, such as raspberry, lime, strawberry, orange, and lemon.

Soda water, the most important ingredient of soft drinks, actually contains no soda. Water charged with carbon dioxide gas causes the water to *effervesce* (bubble) as the gas escapes. Soda water is stored in metal tanks under pressure. It is drawn off and mixed with flavorings to make the finished drink.

WORLD BOOK photo

Soft Drinks are manufactured in many flavors. Most pop consists of soda water, flavorings, and sugar or another sweetener.

Most soft drinks are sold in bottles or cans. But soft drinks are also prepared at soda fountains and dispensed in glasses.

Leading Soft Drink Companies. The soft drink industry has become one of the most profitable American industries. The wholesale value of soft drinks is about $4\frac{1}{3}$ billion a year. The four leading soft drink companies in sales are listed below. Other large companies in the soft drink field include 7-Up and the Dr. Pepper Company.

Coca-Cola Company is the largest soft drink company in the world. It has about 30,000 employees, and annual sales of about $1\frac{3}{4}$ billion. It sells and distributes soft drinks in the United States and many other countries. Coca-Cola was first sold in 1886. Its headquarters are in Atlanta, Ga.

PepsiCo, Inc. is the second largest soft drink company, with annual sales of about $1\frac{1}{2}$ billion. The company has about 40,000 employees. Company headquarters are in New York City.

Canada Dry Corporation, a subsidiary of Norton Simon, Inc., ranks as the third largest soft drink company, with annual sales of more than $187 million. The company makes ginger ale and other carbonated beverages. The headquarters of the company are in New York City.

Royal Crown Cola Company, the fourth largest soft drink company, has annual sales of over $125 million. The company employs about 2,800 persons. It makes flavored beverages and concentrated bases for use in carbonated beverages. Its headquarters are in Columbus, Ga.

History. In 1772, Joseph Priestley of England made the first soda water. He was trying to imitate the natural bubbling water of some mineral springs. The first artificial mineral water contained soda.

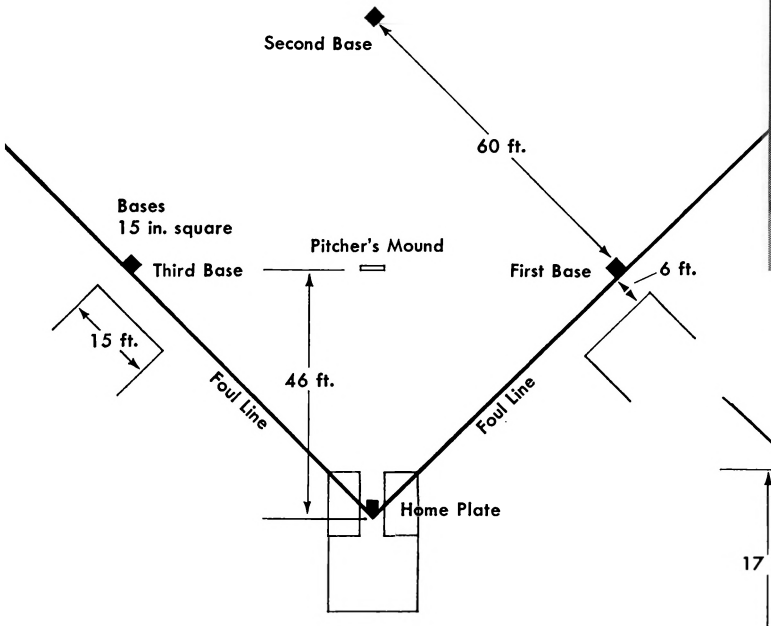
In 1806, Benjamin Silliman, a chemistry professor at Yale College in Connecticut, made and bottled the first artificial soda water in the United States. But drug stores and soda fountains later prepared and dispensed most soda water.

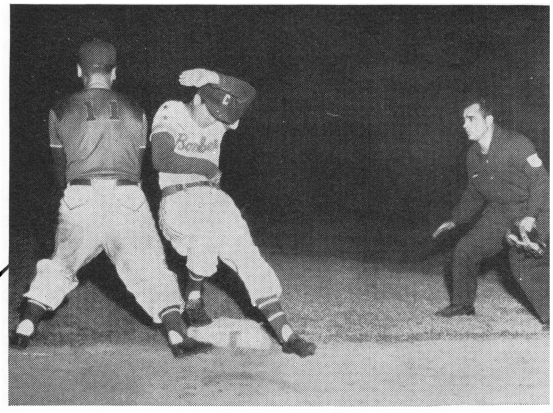
Flavored soda water, especially lemon, became popular after 1830. Ginger ale and root beer became popular later. After 1850, the soft drink industry sold bottled soda water with flavoring.

In 1900, an average of about 12 bottles of soft drinks a person was consumed in the U.S. By the early 1970's, yearly U.S. consumption rose to about 250 bottles or cans a person. Diet drinks with reduced sugar content became popular in the 1960's. CHARLES W. ADAMS

SOFT-SHELLED CRAB. See BLUE CRAB.

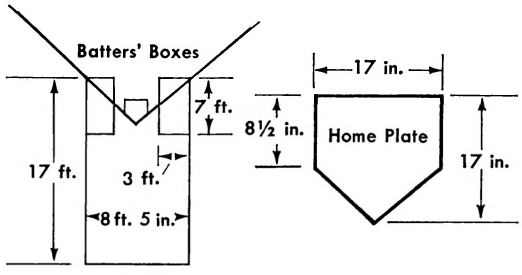
SOFTBALL





Amateur Softball Association

A Close Play at a Base typifies the fun and spirited action of softball games.



SOFTBALL is a game similar to baseball. It is played on a smaller field than baseball, and a larger ball is used (see BASEBALL). Softball began in Chicago as an indoor version of baseball. It became especially popular for school and public recreation programs, because it requires less room and equipment than baseball. By the early 1970's, more than 20 million persons in over 40 countries were playing softball.

All softball pitching must be underhand. The softball pitcher stands 46 feet (14 meters) from home plate instead of $60\frac{1}{2}$ feet (18.4 meters) as in baseball. The base runner cannot leave his base in softball until the ball has left the pitcher's hand. Baseball players can *lead off* (leave) a base. A regulation softball game lasts seven innings. Except for these differences, softball is played like baseball. Women play softball by the same rules as men except that the pitcher stands 40 feet (12 meters) from home plate.

Types of Softball. Every year, men's and women's teams compete in regional, national, and international tournaments. There are two classes of competition, *fast-pitch* and *slow-pitch*. Fast-pitch softball has a nine-man team, and slow-pitch softball has a 10-man team. The tenth man is a short-fielder.

Fast-pitch softball teams play on an infield with the bases 60 feet (18 meters) apart. The players use a ball that measures 12 inches (30 centimeters) around, and a bat that cannot be thicker than $2\frac{1}{4}$ inches (5.7 centimeters). All pitching must be underhand, in a motion similar to that of bowling.

In a common type of slow-pitch softball, the same size infield and ball are used, but the ball must be pitched so that it arches on its way to the batter. Unlike fast-pitch softball, slow-pitch rules do not allow bunting or base stealing. Many persons play a slow-pitch game with a 14- or 16-inch (36- or 41-centimeter) ball. Slow-pitch softball is popular in the United States and in several other nations.

History. Softball was developed in 1887 by George W. Hancock of the Farragut Boat Club in Chicago. Hancock designed the game for indoor play with a 16-inch ball that had the seams turned out. In 1895, Lewis Rober of the Minneapolis Fire Department adapted the game for outdoors. He used a 12-inch ball that had a cover similar to that used in baseball. Rober's version is considered the forerunner of the present game of softball.

In 1923, the National Recreation Association appointed a committee of recreation executives to study the variety of rules used in different parts of the United States so that they could be standardized. Many of the rules were later changed by a joint rules committee formed in 1933. The Amateur Softball Association, founded in 1933, is the governing body of the sport in the United States. It has aided the development of softball in the U.S. and other countries. International softball competition is governed by the International Softball Federation, founded in 1952. The international federation now has more than 40 member countries.

DON E. PORTER

SOFTWOOD. See LUMBER (Softwood Lumber); TREE (Needleleaf Trees; Needleleaf Forests); WOOD.

SOGDIANA. See ALEXANDER THE GREAT (The Battle of Arbela).

SOIL is the covering over most of the land surface of the earth. It is made up of rock and mineral particles of many sizes mixed with living things and their remains. It is shallow in some places, deep in others. It may be red, as it is in Georgia, or it may be very black, as it is in North Dakota. It may be sand or clay.

A geologist thinks of soil as the loose material that covers the solid rocks below the earth's surface. An engineer thinks of soil as the material on which he erects buildings and other structures. He also regards it as material from which to build roads, earth dams, or landing strips for airfields. But to the farmer and to most people, soil is the thin layer at the earth's surface that will support the growth of plants of all kinds.

Ernest E. Wahlstrom, the contributor of this article, is Professor of Geology and Dean of Faculties at the University of Colorado.

Soil is one of the most important natural resources of any country. That is why great efforts are made to conserve soil. When the soil becomes unable to grow good crops, not enough food can be produced to feed the people. The strength of the nation declines.

How Soil Is Formed

It takes a long time for soil to form. In places where the climate is moist and warm and is just right for making soil out of rocks, it takes thousands of years to form even a shallow layer of soil. In places where it is very cold or in dry desert regions, soil forms only with great difficulty, or not at all.

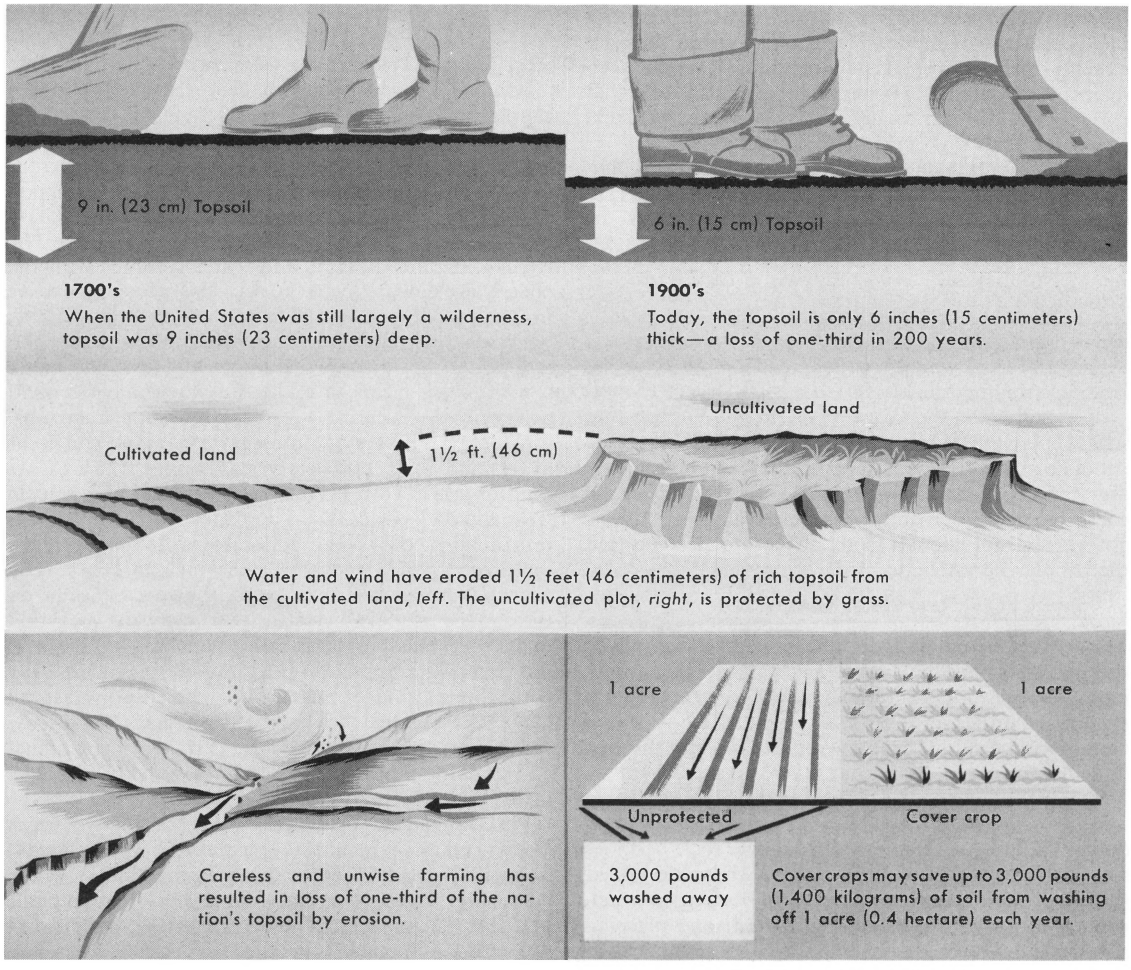
Soil is formed in two general ways. The action of weather on rocks causes them to decompose, or break down. Little by little the surface of the rock becomes softer and decays to become soil. Such soil is called *residual soil*. Soil surfaces may also be formed when wind, water, or glaciers carry soil from one place to another. Soil deposited by rivers and streams is called *alluvium*. Soil moved by glaciers is called *till*. Fine soil, blown about by the wind before it is deposited, is called *loess*. This soil is finer than sand, but coarser than clay.

Many soils, when they are first deposited, will not support much plant life. They usually do not have enough food in them to allow complex plants, such as corn or wheat, to thrive. They are ready to grow crops for the farmer only after they undergo many changes.

Air. Air helps to make soil because it contains oxygen, carbon dioxide, nitrogen, and moisture. The oxygen, carbon dioxide, and water combine with the chemical elements in the rocks. This causes the rocks to decay and break down into small particles. Plants, which also help to break down rocks, need the nitrogen and water. For example, the root of a tree can crack a rock. Wind helps to make soil when it blows sand against rocks, wearing the rocks into tiny fragments.

Water. The force of running water alone can wear away hard rock. But nearly all running water carries sand or gravel with it, and these particles also help to wear the rock away. Rain and snow help break rocks into small pieces. When water freezes in cracks in the rocks, it expands and causes the rock to break. The constant process of freezing and thawing of water on the surface of rocks helps to wear away the rock and make soil. This process is called *weathering*. Oxygen in the water, like oxygen in the air, combines chemically with the substances that have been dissolved from rocks. Glaciers help to make soil by scraping up loose rocks from the earth's surface, carrying them along, and grinding them into small pieces. When the glacier melts, the soil remains behind.

Plants increase the value of the soil in two ways. They send their roots through the soil, which breaks it up and makes it better for growing things. When plants die, they decay and form *humus*, an organic material that makes the soil more fertile (see HUMUS). The roots of plants, although tiny, are very strong. They have been known to split hard rocks. Small plants called bacteria help the green plants to decay.



Animals also help to keep the soil fertile. Body wastes of many animals enrich the soil. When an animal dies, its body decays and adds important materials to the soil. Animals that burrow beneath the soil surface help to mix the soil. Perhaps the most valuable of all these animals are the earthworms. To obtain food, earthworms take soil into their bodies and pass it out again in a finely pulverized state (see EARTHWORM).

How Soil Is Destroyed

Cultivated land can be seriously damaged by soil erosion (see EROSION). It takes hundreds of years to build up 1 inch (2.5 centimeters) of topsoil. But all the topsoil on a farm can be washed away by rains in less than 20 years. When the first colonists came to North America, they found rich soil. The early settlers quickly exhausted their soil by not fertilizing it and by failing to take steps that would prevent erosion.

As the pioneers pushed westward across the continent, they left worn-out soils behind them. When they cut down trees to clear the land for farms, they increased the amount of open soil that could be carried away by rain water. Rain not only washes away the soil itself, but also dissolves important chemicals in the soil and carries them away. Scientists believe that almost six times as much of the plant food in the soil is washed away by rain as is taken out of the soil by growing crops.

Water is not the only thing that destroys soil through erosion. During and immediately after World War I, much grassland was plowed up and planted with wheat because of the importance of wheat on the world market. When this land lost the covering of grass that had protected it, winds easily swept up the topsoil and carried it away. The dust storms that occurred during the middle 1930's ruined many farmlands in the Middle West. This area was called the *Dust Bowl*. See DUST BOWL; DUST STORM.

Various methods were used to prevent further erosion by the elements. Trees were planted along a shelter belt to check wind erosion. Farmers planted crops such as kudzu and lespedeza, which grow quickly and send out vast networks of roots. The roots hold the soil in place and keep the rain from washing it away. Terraces, which also help to hold the soil in place or catch the soil as it washes down, were built on hillsides. Contour plowing, in which the plow runs across the slope of the land rather than with it, was adopted to keep the water from running off the field too quickly.

Soil erosion is also an important problem in other countries. Palestine (now Israel) was once a fertile country, but erosion washed off so much soil that most of the land became barren. Similar erosion took

place in Greece and North Africa. See CONSERVATION (Soil Conservation).

Characteristics of Soil

To the farmer, soil has four important characteristics. These are: (1) depth, (2) structure, (3) texture, and (4) the chemical elements that are found in it.

Depth. *Topsoil* is the essential part of the soil for agriculture. It seldom lies deeper than the depth of a spade over any part of the earth's surface. Topsoil is generally deepest in valleys. It is thinnest near the tops of hills and mountains. Beneath the topsoil is another layer of soil that may be 2 or 3 feet (61 or 91 centimeters) deep. This is called the *subsoil*.

Structure of the soil is important because it shows how well the various grains that make up the soil cling together. In the ideal plant soil, each grain is not entirely separate. Rather, it tends to form small crumbs with other grains. Humus is valuable in soil because it tends to help the particles cling together.

Texture of the soil depends entirely upon the size of the grains or particles that make it up. The largest particles are the pebbles and small rocks that we call gravel. The smallest particles are found in clay soil. Between these two in size are the particles that make up silt and sand. Particles of sand are large enough to feel gritty when the soil is rubbed between the fingers. Particles of silt are just large enough to be seen. Decayed animal or plant matter in the soil is called humus.

Most soils are not pure sand, clay, or silt. Rather, they are mixtures of all the particles found in the soil. Such mixtures are called *loam*. To be considered a sandy soil, the soil must be at least half sand. Clay soil must be at least half clay. Clay soils are called *heavy* soils because their particles are packed tightly together. Sandy soils are considered *light* because the particles are loose.

The texture of the soil often helps to determine its fertility. Sandy soil, for example, is not good for growing plants. It does not hold water well. Clay soil is not good either, for it is packed so tightly that not enough air can reach the plant roots. A fine loam, with a large amount of silt and humus, is usually the best kind of soil.

Chemical Make-Up. Plants obtain much of their food from the soil. For this reason it is necessary that the chemicals that provide these foods be found in the soil. If these foods do not exist in the soil, they must be added. Fertilizers are used for this purpose. Sodium, potassium, calcium, phosphorus, magnesium, iron, and chlorine are essential for the growth of all living substances. If one crop takes too much of these substances from the soil, the farmer must replace them. Phosphorus, the nitrates that contain nitrogen, and calcium must often be replaced. But some of the substances rarely need replacement. For example, most soils contain enough iron so that it is usually not used up. Some soils contain too much acid. In this case the farmer adds lime to make the soil more alkaline.

The chemical composition of soil also influences the health of animals. Plants obtain minerals from the soil. As the animals eat the plants, these minerals are passed on to them. Some of these minerals are poisonous. For example, in some western states the soil contains selenium, a mineral harmful to animals. The plants that grow in this area can use the selenium without much harm. But if animals eat plants grown in soil that contains selenium, they are poisoned.

International Harvester Co.

Most Soil Needs Fertilizer to help it produce a sturdy crop, and also to keep it healthy for the next planting. Tractor-drawn fertilizer distributors spread the fertilizer evenly, efficiently, and quickly over all the soil in a field.

Kinds of Soil

Scientists who specialize in the study of soil are called *pedologists*. They have developed many ways of classifying soil other than on the basis of the particles that make it up.

As soils develop from solid rock, alluvium, till, or loess, several changes take place that depend on the climate. In the eastern United States, where there is abundant rainfall, moisture seeps downward through the top layer, called the *zone of leaching*, or the *A horizon*. This moisture dissolves the chemical elements such as sodium, calcium, and magnesium, and carries them away to the rivers and the sea. Below the top layer of soil, insoluble iron oxides and clay minerals are deposited in another layer. This is called the *zone of accumulation*, or the *B horizon*. The B horizon grades downward into the *C horizon*, which contains a mixture of decomposed rock and unchanged materials from which soil has not yet begun to form.

In the western United States, where there is little rainfall, calcium carbonate is formed and remains in the soil, especially in the B horizon. Deposits of calcium carbonate in such soils form a whitish material called *caliche*. Soils that are poor in calcium are called *pedalfers*. Soils that contain much calcium are called *pedocals*. In tropical regions, soils become rich in aluminum and red-colored iron oxides. These soils are called *laterites*.

There are many varieties of each of the major kinds of soils and many gradations between them. Exact classification of soils can be made only by experts who specialize in the study of soils. ERNEST E. WAHLSTROM

Related Articles. See the Natural Resources sections of the various country, state, and province articles. See also the following articles:

Agronomy	Erosion	Loam
Alkali	Farm and Farming	Loess
Clay	Fertilizer	Permafrost
Conservation	Gardening	Soil Bank
Drainage	Humus	Soil Conditioner
Dust Bowl	Irrigation	Soil Conservation Service
Earthworm		Topsoil

Monsanto

Adding a Soil Conditioner improves the structure of cracked, crusty soil, and enables seeds to germinate.

Soil Conservation—USDA

A Soil Conservationist helps farmers and ranchers put their land and water resources to the best possible use.

SOIL BANK was a United States federal government program designed to reduce crop surpluses by taking croplands out of production. The program consisted of a short-term *acreage reserve plan* and a long-term *conservation reserve plan.* It was adopted in 1956, but was replaced by other programs in the early 1960's.

The acreage reserve plan provided government payments to farmers who agreed to take designated cropland out of production for a year. The conservation reserve plan provided for annual government payments to farmers who agreed to keep land out of production for from three to ten years.

Critically reviewed by the DEPARTMENT OF AGRICULTURE

SOIL CONDITIONER is a synthetic chemical or natural substance that improves soil structure. Good soil structure helps plants grow by bringing air and water to the roots. It also lessens erosion and prevents soil from crusting. Manure, peat, leaf mold, and other natural substances are more effective and less expensive than synthetic chemicals such as Krilium. Natural conditioners also provide plant food, but synthetic ones do not. See also SOIL (Texture). HENRY T. NORTHEN

SOIL CONSERVATION. See CONSERVATION (Soil Conservation); EROSION.

SOIL CONSERVATION SERVICE is an agency of the United States Department of Agriculture. Its main purpose is to help farmers and ranchers use their land and water resources to reduce loss by flood or erosion. The service gives assistance through soil-conservation districts and other state and federal agencies. It makes soil surveys, develops technical plans for individual farms, and lends special equipment to carry out the conservation practices. This agency also manages a national program of flood prevention, drainage and irrigation, and watershed protection. The Soil Conservation Service was established in 1935. JOHN C. BOLLENS

SOIL POLLUTION. See ENVIRONMENTAL POLLUTION (Soil Pollution).

SOILLESS AGRICULTURE. See HYDROPONICS.

SOKOL, *SO kohl,* is a gymnastic organization with local societies in Eastern Europe, particularly in Poland and Czechoslovakia, and in the United States. The Sokol movement stresses the physical development of young people, and also promotes patriotism and character development. Sokol was founded in Prague in 1862. The United States branch of the society was founded in 1865. Sokol activities in Europe are now controlled by Communist governments.

SOL. See CALENDAR (Calendar Reform); COLLOID.

SOL, *sohl,* is a standard silver coin used in Peru. One hundred centavos equal one sol. The radiant sun pictured on the coin gives the sol its name. Sol also is the name of a coin formerly used in France. For the value of the sol, see MONEY (table: Values).

SOLANACEAE. See NIGHTSHADE.

SOLANUM, *soh LAY num,* is an important group of plants that belong to the nightshade family. More than 1,000 different kinds of herbs and shrubs are included in the group. They grow in many parts of the world, but are especially abundant in tropical regions of North and South America. Some of the plants are cultivated for their showy flowers, others for their edible parts.

The most common species of solanum is the *potato.* Another is the *eggplant.* A few of the other species of the temperate regions are *bittersweet* and *common nightshade.* The *horse-nettle* and other spiny troublesome weeds are native to the United States. Several species were once used as medicine, and are still used in China. The fruits of many Indonesian varieties are eaten. The *kangaroo-apple* is a common food in Australia and New Zealand.

Scientific Classification. Solanums are genus *Solanum* in the nightshade family, *Solanaceae.* GEORGE H. M. LAWRENCE

Related Articles in WORLD BOOK include:

Bittersweet	Flowering Tobacco	Painted-Tongue
Eggplant	Nightshade	Potato

SOLAR CELL. See SEMICONDUCTOR.

SOLAR DAY. See DAY.

SOLAR ECLIPSE. See ECLIPSE.

SOLAR ENERGY is energy given off by the sun. This energy is produced by atomic reactions that take place inside the sun. During these reactions, the sun changes hydrogen atoms into helium atoms. Every second, the sun changes about 657 million short tons (596 million metric tons) of hydrogen into 653 million short tons (592 million metric tons) of helium. The missing 4 million short tons (3.6 million metric tons) of matter is changed into energy. The sun began to give off energy about 5 billion years ago. Scientists believe it will continue to supply energy for at least another 5 billion years.

It is difficult to imagine the huge amount of energy given off by the sun. Suppose that gasoline flowed over Niagara Falls at the same rate that water flows over the falls—5 billion gallons (19 billion liters) per hour. Now suppose that all the gasoline that flowed over the falls for more than 200 million years could be collected. If all that gasoline were burned, it would equal the energy that the sun gives off in an hour.

Scientists and engineers use a unit called a *kilowatt* to measure power. The sun continuously produces 390 sextillion (390 followed by 21 zeros) kilowatts of power. But the sun gives off energy in every direction. As a result, only about 1 two-billionth of the sun's energy ever reaches the upper atmosphere of the earth. Even so, the earth receives more than 1,500 quadrillion (1,500 followed by 15 zeros) kilowatt-hours of power each year. Imagine a loaded coal train that is long enough to reach from the earth to the moon and back five times. If all the coal on this train were burned, it would produce the same amount of energy that reaches the upper atmosphere of the earth from the sun in an hour.

Not all the solar energy that reaches the upper atmosphere gets to the surface of the earth. About 34 per cent is scattered into space by the gases and dust in the atmosphere, or it is directly reflected back by clouds. About 19 per cent is absorbed by the different layers of the atmosphere. This energy creates changes in the weather. The remaining 47 per cent of the solar energy finally reaches the ground or ocean, where it is absorbed as heat.

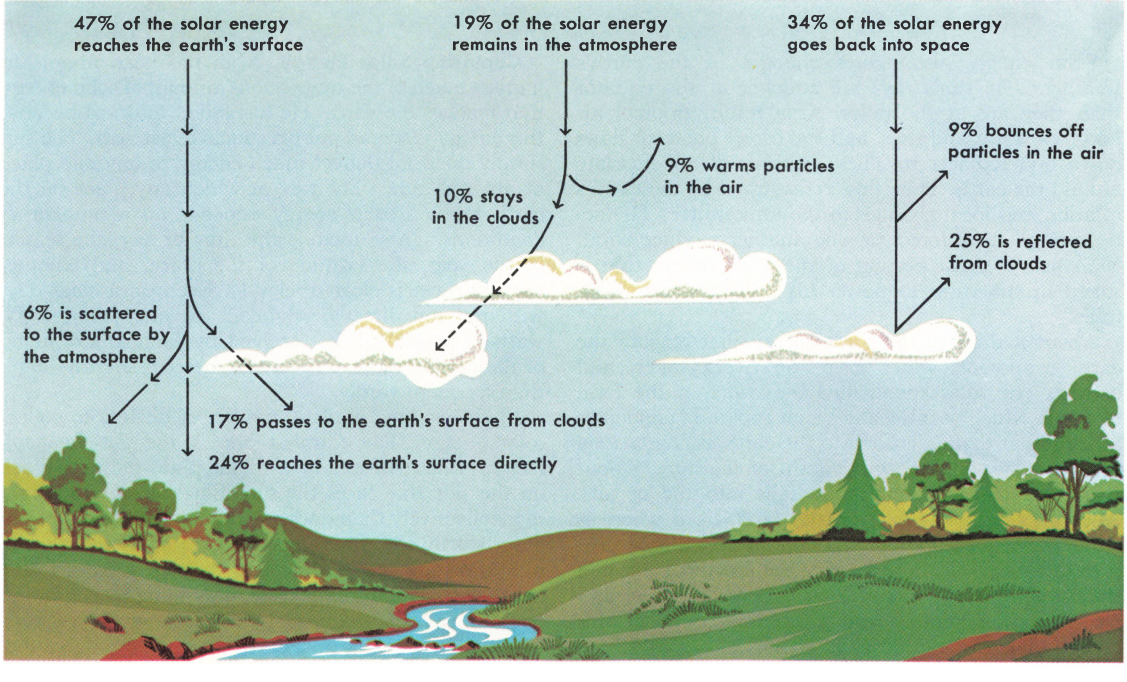
More than 700 quadrillion kilowatt-hours of power reach the earth's surface each year. Man uses more than 50 trillion kilowatt-hours of power to run factories, machines, and vehicles and to heat buildings. These figures show that in 40 minutes the sun delivers to the earth's surface as much energy as man uses in a year.

How Solar Energy Affects the Earth. All plants and animals on the earth need the energy of the sun to live. Green plants, by means of a process called *photosynthesis*, store solar energy as food (see PHOTOSYNTHESIS). During photosynthesis, solar energy is changed to chemical energy by plant cells that contain chlorophyll. These cells use the chemical energy to manufacture the compounds that make up the branches, leaves, roots, and other parts of plants. Animals that eat green plants absorb the energy stored by the plants. Even animals that do not eat plants depend on plants for their food energy. Such animals eat other animals that had fed on plants.

HOW THE ATMOSPHERE AFFECTS THE AMOUNT OF SOLAR ENERGY REACHING THE EARTH

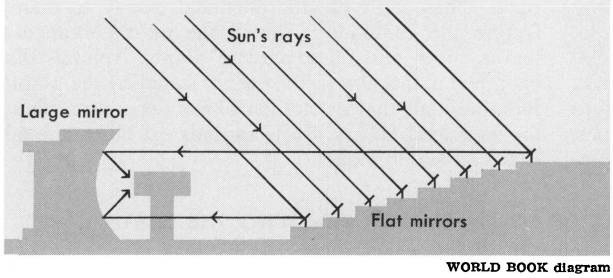
All the solar energy that strikes the upper atmosphere does not reach the earth's surface. Clouds and particles in the air reflect some energy, and the air itself absorbs some. This diagram shows what percentage of the sun's energy entering the upper atmosphere reaches the earth's surface.

WORLD BOOK diagram



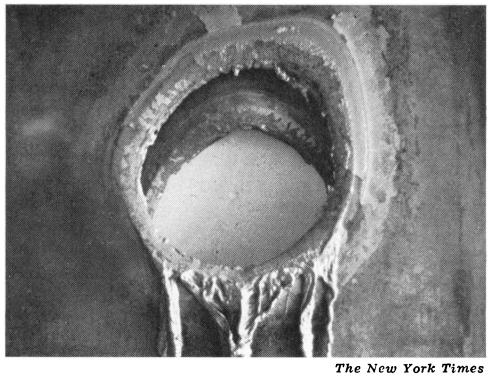
The New York Times

A Large Solar Furnace operates on a slope of the Pyrenees Mountains in France. The large mirror, *upper left*, focuses the sun's rays onto the building in front of it. The building holds objects to be heated by the furnace.



WORLD BOOK diagram

The Sun's Rays Enter the Furnace from flat mirrors placed on a nearby hillside. These mirrors turn to follow the sun as it moves across the sky so they can reflect the sun's rays toward the large mirror.



The New York Times

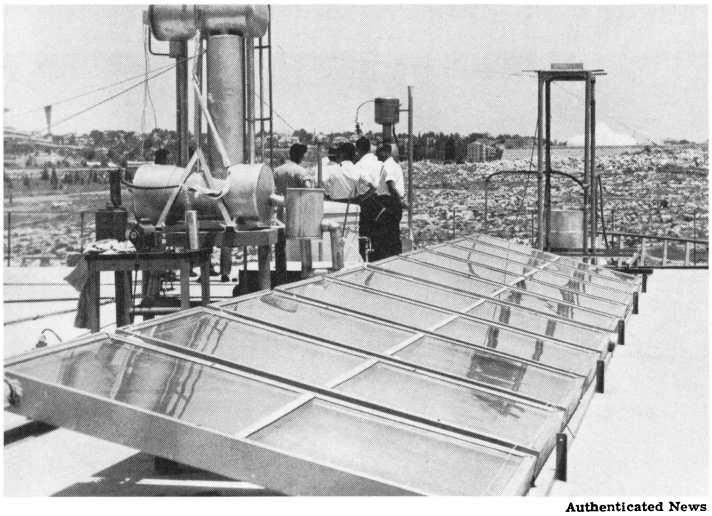
The Furnace Melts a Steel Plate in about a minute, using concentrated solar energy. The furnace can reach temperatures as high as 5975° F. (3302° C) in seconds.

Solar energy also causes changes in the earth's weather. The sun's rays are stronger at the equator than they are at the poles. As a result, tropical air becomes warm and rises, and the cooler polar air flows down and replaces it. These currents of air circulate around the earth. Their flow is disturbed by the earth's rotation and local changes in the atmosphere. The actions of all these forces on one another produce wind. Man uses a small portion of the solar energy that is stored in the wind to power his sailboats and windmills.

About a third of the sun's energy that reaches the earth evaporates water from the rivers, lakes, and oceans. The solar energy lifts the water in the form of vapor. Much of this water vapor cools and condenses as it rises. It then falls back to the earth as *precipitation* —rain, snow, or some other form of moisture. About two-thirds of the precipitation falls into the oceans. About a third of it falls on the land, from where it either evaporates again or flows into a river that returns it to the sea. Thus, the energy of the flowing water in a stream is a form of stored solar energy. Man's hydroelectric power stations use a small amount of this energy to generate electricity.

Capturing Solar Energy. Man has been unable to harness much of the tremendous amount of solar energy that reaches the earth. He has failed to do so because this energy is spread out over such a vast area. The sun simply does not deliver much energy to any one place at any one time. The rate at which any place on the earth receives solar energy depends on a number of conditions. These include the time of day, the season of the year, the latitude of the place, and whether the sky there is clear or cloudy. Even on a clear day, with the sun directly overhead, no more than 1,000 watts of power will be received by each square meter of the earth's surface. A square meter is slightly larger than a square yard.

Engineers have built a number of devices to collect solar energy. The simplest one is the *flat-plate* collector, which consists of a metal plate painted black on the side that faces the sun. Black absorbs sunlight more effectively than does any other color. The sunlight absorbed by the plate heats it. One or more layers of plastic or glass cover the plate to keep it from losing heat. The plate also has insulation along its edges and back. The heat produced by solar energy is removed by circulating water or some other fluid through tubes



Authenticated News

Flat-Plate Collectors trap the heat produced by sunlight. Glass or plastic over the plate, and insulation around the rest of the plate, keep the heat from escaping. A liquid circulating through pipes behind the plate removes the heat.

Authenticated News

Solar Batteries produce electricity when sunlight shines on them. The panel shown above can produce 5 watts of electricity.

soldered to the back of the plate. Flat-plate collectors have been used to heat houses and to distill fresh water from sea water.

Solar energy can create high temperatures through the use of a device that concentrates the sun's rays. One such device is the *solar furnace*. A *parabolic mirror* concentrates solar energy on a small area in front of the mirror (see PARABOLA). Simple solar furnaces can create temperatures as high as 4900° F. (2700° C). In the late 1960's, French scientists built a solar furnace in the Pyrenees Mountains that could reach temperatures near 5975° F. (3300° C).

The sun's energy supplies the electric power for nearly all artificial satellites. Devices called *solar cells* or *solar batteries* on the outside of a satellite produce electricity when sunlight shines on them. Solar cells and batteries are made from thin slices of *semiconductor* materials (see SEMICONDUCTOR).

A solar cell has an *efficiency* of about 10 per cent. That is, only about one-tenth of the solar energy that falls on the cell is turned into electric energy. Solar cells make up for low efficiency by their high reliability. A satellite with solar cells has a reliable source of electricity for many years.

Early Attempts to Harness Solar Energy. The idea of using solar energy to produce high temperatures goes back to ancient times. Some historians believe that Archimedes, a Greek mathematician of the 200's B.C., set fire to Roman ships by concentrating the sun's rays on them with flat mirrors. In 1774, the French chemist Antoine Lavoisier built a solar furnace with a lens about 4 feet (1.2 meters) in diameter. His furnace reached a temperature of 3092° F. (1700° C).

In the 1870's and 1880's, the Swedish-American engineer John Ericsson tried to develop a system to change solar energy into mechanical energy. One of his devices supposedly produced 1 horsepower (746 watts) for each 100 square feet (9.3 square meters) of collecting surface.

Modern research on the use of solar energy started during the 1930's. Developments included the invention of a solar boiler by Charles G. Abbot, an American physicist, and the start of the Godfrey Cabot solar programs at Harvard University and the Massachusetts Institute of Technology. In 1954, the Bell Telephone Laboratories developed the solar battery. That same year, solar-energy scientists in the United States formed the Association for Applied Solar Energy to investigate ways to harness the sun's energy.

A number of scientists have proposed using solar energy to heat homes. Since 1940, several solar-heated structures have been built and tested. In 1958, the Massachusetts Institute of Technology built a solar-heated house in Lexington, Mass. This house had flat-plate collectors that formed a portion of the roof. The water heated in the collectors was stored in a tank until it was needed to heat the house. However, solar energy provided only about half the heat that the house required. An ordinary heating system supplied the rest of the heat. The need for an ordinary system makes the high cost of solar heating hard to justify in areas with severe winters.

STANLEY W. ANGRIST

See also SUN.

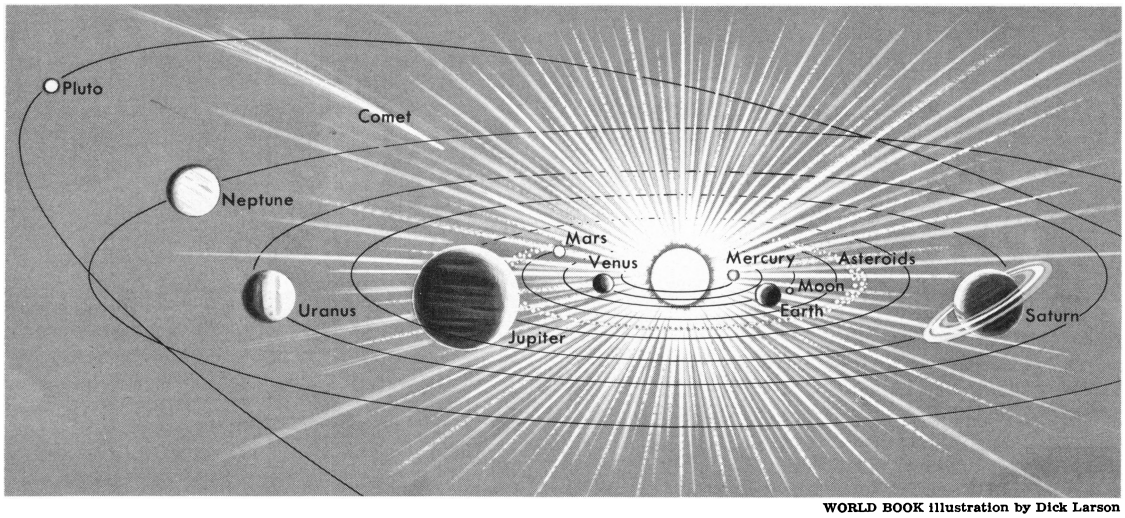
SOLAR FURNACE. See SOLAR ENERGY (Capturing Solar Energy; picture).

SOLAR PLEXUS is a large network of nerves back of the stomach. It is part of the autonomic nervous system. This system controls all the abdominal *viscera* (internal organs). The nerve threads of this system connect by branches with the organs of the abdominal cavity.

A blow on a spot between the navel and breastbone, a little to the right, is called the solar plexus punch. A fighter can be knocked out by this punch if it is hard enough. The exact manner in which this occurs has not been determined. The solar plexus first became well known in 1897 as a result of the championship boxing match between James Corbett and Robert Fitzsimmons. Fitzsimmons knocked out Corbett with a blow to the solar plexus.

W. B. YOUMANS

See also NERVOUS SYSTEM.



WORLD BOOK illustration by Dick Larson

The Solar System Includes Many Different Objects that travel around the sun. These objects vary from planets much larger than the earth to tiny meteoroids and dust particles.

SOLAR SYSTEM is the sun and all the objects that travel around it. The solar system includes (1) the earth and eight other *planets*, along with the *satellites* (moons) that travel around most of them; (2) planet-like objects called *asteroids;* (3) chunks of iron and stone called *meteoroids;* (4) bodies of dust and frozen gases called *comets;* and (5) drifting particles called *interplanetary dust*, and a drifting gas called *interplanetary plasma.*

The solar system has a circular shape. It is only a tiny part of a *galaxy* (family of stars) called the *Milky Way.* The Milky Way consists of more than 100 billion stars that are somewhat similar to the sun. The Milky Way, which also has a circular shape, is about 100,000 light-years across, and about 16,000 light-years thick at its center. A *light-year* is the distance light travels in one year at a speed of 186,282 miles (299,792 kilometers) per second. The solar system is less than one *light-day* (the distance light travels in one day) across. It is about 30,000 light-years from the center of the Milky Way. The galaxy turns, and the solar system travels around the center of the Milky Way about every 200 million years.

Many stars in the Milky Way are the centers of solar systems. Some astronomers think many of these systems may have some form of life. The nearest solar system that might have intelligent life is about 100 light-years away. It would take 100 years for a radio message sent from the earth at the speed of light to reach this solar system, and another 100 years for a reply to reach the earth.

Parts of the Solar System

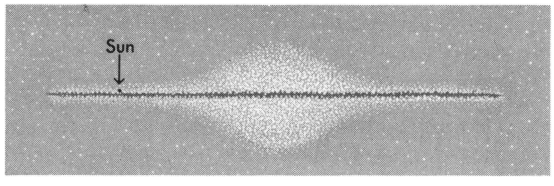
The Sun is the center of the solar system. Its *mass* is more than 750 times as great as that of all the planets combined (see MASS). The huge mass of the sun creates the gravitation that keeps the other objects traveling around the sun in an orderly manner.

The sun continuously gives off energy in several forms—visible light; invisible *infrared, ultraviolet, X,* and *gamma* rays; radio waves; and *plasma* (hot, electrically charged gas). The flow of plasma, which becomes interplanetary plasma and drifts throughout the solar system, is called the *solar wind* (see SOLAR WIND).

The surface of the sun changes continuously. Bright spots called *plages* and dark spots called *sunspots,* frequently form and disappear. Gases often shoot up violently from the surface. For a complete description of the sun, see the article SUN.

Planets are the second largest objects in the solar system. The four planets nearest the sun—Mercury, Venus, Earth, and Mars—are the smallest planets, although Pluto's size has not been accurately determined. Those four planets are called *terrestrial* (earth-like) planets, and appear to consist chiefly of iron and rock. The earth has one satellite, and Mars has two. Mercury and Venus have no satellites.

The four largest planets—Jupiter, Saturn, Uranus, and Neptune—are called the *major* planets. They are probably made up chiefly of hydrogen, helium, ammonia, and methane. Compared to the terrestrial



The Milky Way is made up of more than 100 billion stars similar to the sun. Many stars have their own solar systems. This side view of the Milky Way shows the position of the sun in the galaxy.

The contributor of this article is A. G. W. Cameron, Professor of Space Physics at the Belfer Graduate School of Science of Yeshiva University.

planets, they contain little iron and rock. Each of the major planets has several satellites. Pluto, the farthest planet from the sun, appears to be somewhat like the terrestrial planets. But because Pluto is so far away, astronomers know little about it and do not include it in either group.

All the planets except Pluto are surrounded by varying kinds and amounts of gases. The earth is the only planet that has enough oxygen surrounding it and enough water on its surface for life as we know it. For a more complete description of the planets, see the article PLANET and the separate articles on each planet.

Asteroids, also called *planetoids*, are small, irregularly shaped objects. Most asteroids are between the orbits of Mars and Jupiter. Astronomers have figured out the sizes and orbits of about 1,700 of the largest asteroids. Only a few are larger than 100 miles (160 kilometers) across, and many are less than 1 mile (1.6 kilometers) across. Astronomers believe the asteroid belt includes large amounts of dust created by collisions between asteroids. See ASTEROID.

Meteoroids are small chunks of iron and rock that also are thought to result from collisions between asteroids. Many meteoroids fall into the earth's atmosphere, but most are burned up by friction before they reach the surface of the earth. Meteoroids are called *meteors* while falling through the atmosphere, and *meteorites* if they are found on the earth's surface. See METEOR.

Comets. Most comets have three parts: (1) a solid *nucleus*, or center; (2) a round *coma*, or head, that surrounds the nucleus and consists of dust particles mixed with frozen water, frozen methane, and frozen ammonia; and (3) a long *tail* of dust and gases that escape from the head. Most comets stay near the outside of the solar system. Some come near the sun, where their bright heads and long, shining tails provide a rare and spectacular sight. See COMET.

Formation of the Solar System

Astronomers do not have enough information to describe the formation of the solar system completely. Many ideas have been suggested, but parts of all of them have been proved wrong.

Until the mid-1900's, theories of how the solar system was formed could be based on only five important observations. (1) The sun and most other parts of the solar system spin in the same direction on their *axes* (imaginary lines drawn through their centers). (2) Most parts of the solar system travel around the sun in the same direction that the sun spins. (3) Most satellites travel around their planets in the same direction that the planets travel around the sun. (4) Going outward from the sun, the distance between the orbits of the planets increases. (5) The solar system has a circular shape.

The theories that have been suggested to explain the above observations can be divided into two general groups—*monistic theories* and *dualistic theories*. Most astronomers believe that some form of monistic theory will someday be proved correct.

Monistic Theories are based on the belief that the solar system was formed from a single flat cloud of gas. According to some monistic theories, all parts of the solar system were formed from the gas at the same time. Other monistic theories suggest that the sun was formed first, and the planets and other objects came later from the remaining gas. The first monistic theory was proposed in the early 1600's by the French scientist and philosopher René Descartes. In the late 1700's, Pierre Simon de Laplace, also of France, suggested the monistic theory called the *nebular hypothesis*.

Dualistic Theories are based on the belief that the solar system was formed when some huge object passed near the sun. According to these theories, the force of gravity of the passing object pulled a long stream of gas out from the sun. The planets and other objects were formed from this gas. The first dualistic theory was proposed in the 1700's by the French scientist Comte de Buffon. Buffon believed the passing object was a large comet, which he incorrectly thought was as large as a star. In the early 1900's, Thomas Chamberlin and Forest Moulton, both of the University of Chicago, offered a dualistic theory called the *planetesimal hypothesis*.

Theories Since the Mid-1900's are helping scientists come closer to learning how the solar system was formed. For example, astronomers have discovered that the Milky Way is at least twice as old as the solar system. For that reason, the processes of star formation seen in the galaxy today are probably similar to the processes that formed the sun.

The study of meteorites is producing new information about temperatures, pressures, and other conditions that probably existed during the formation of the solar system. Measurements of the radioactivity of meteorites indicate that they were formed at about the same time as the solar system, about $4\frac{1}{2}$ billion years ago.

Information gathered by artificial satellites and space probes indicates that the atmospheres and interiors of the other planets differ greatly from those of the earth. A complete theory of the formation of the solar system probably cannot be developed from studies of the earth alone. See UREY, HAROLD CLAYTON.

By studying the sun, astronomers hope to learn how the center of the sun heats its outer atmosphere. Astronomers also want to find why the formation of sunspots reaches a peak about every 11 years.

By studying the planets, astronomers hope to discover how various chemical elements are spread through the solar system. They hope to learn whether planets have liquid centers, and why some planets have large amounts of carbon dioxide in their atmospheres.

Exploration of the moon is expected to provide knowledge of how and when the moon was formed. Astronomers also want to know whether there are volcanoes on the moon, and whether the interior of the moon is similar to that of the earth.

A. G. W. CAMERON

Related Articles in WORLD BOOK include:

Astronomy	Mars	Pluto
Earth (The Birth of the Solar System)	Mercury	Saturn
Galaxy	Milky Way	Star
Gravitation	Moon	Sun
Jupiter	Neptune	Uranus
	Planet	Venus

See *Solar System* in the RESEARCH GUIDE/INDEX, Volume 22, for a *Reading and Study Guide.*

SOLAR WIND is an extremely thin gas that streams outward from the surface of the sun and through interplanetary space. It consists of electrically charged particles. The solar wind streams from the sun constantly, but it does not flow evenly.

The solar wind is made up mainly of protons and electrons. About 4 per cent of it consists of helium nuclei. All these types of particles travel past the earth at speeds of about 300 miles (480 kilometers) per second. In comparison, the earth travels in its orbit at a speed of only 18½ miles (30 kilometers) per second. The streaming gas of the solar wind contains only about 5 particles per cubic centimeter of space. In contrast, there are more than one billion billion (1,000,000,000,000,000,000) molecules of gas per cubic centimeter of air in the earth's atmosphere at sea level.

The existence of the solar wind had been predicted before it was discovered. In 1962, measurements by the Mariner II space probe confirmed its existence. The exact source of the particles on the sun is not known.

As the solar wind flows past the earth, the particles are affected by the earth's magnetic field. Astronomers believe that some of them may become trapped in the *magnetosphere*, the region of space influenced by the earth's magnetic field. ERIC D. CARLSON

See also EARTH (illustration: The Earth Has a Magnetic "Tail").

SOLDER, *SAHD er*, is a metal alloy used to join metal surfaces together (see ALLOY). It is also used to mend metal objects. To be effective, the solder must melt more easily than the metals to which it is applied.

There are two types of solder, hard and soft. Hard solders will melt only at high temperatures. The advantage of hard solders is their strength and the fact that they can be pressed or hammered into various shapes without breaking. Some hard solders are drawn out into long threads and others are pressed into sheets. The most common hard solder is silver solder, which consists of silver, copper, and zinc. Other common solders include brasses made up mainly of copper and zinc. Many copper alloys are also used as hard solders.

Soft solders will melt at low temperatures. But they are brittle and cannot be hammered without breaking. The most common soft solders include various alloys that consist mainly of tin and lead. These alloys also contain other metals such as antimony, cadmium, bismuth, and silver. WILLIAM W. MULLINS

SOLDIER. See ARMY; ARMY, UNITED STATES; RANK IN ARMED SERVICES.

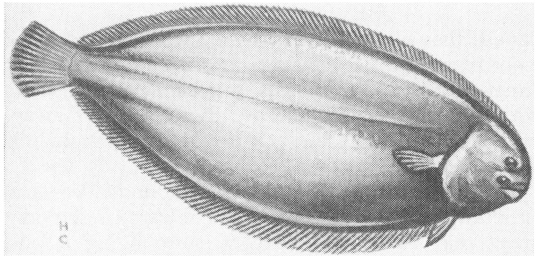
SOLDIERS' BONUS. See BONUS.

SOLDIERS' HOMES. See VETERANS ADMINISTRATION.

SOLDIER'S MEDAL. See DECORATIONS AND MEDALS.

SOLE is the name of a family of flatfishes which have twisted skulls so that both eyes are on the same side of the body. Soles live in warm seas near shores. Their eyes are small and set close together. The mouth is crooked, and the body flat and oval shaped.

The *European sole* grows from 10 to 20 inches (25 to 51 centimeters) long, and usually weighs about 1 pound (0.5 kilogram). The *common American sole*, also called *hogchoker*, lives along the eastern coast of North America. It may travel far up rivers. The American sole is often used as food. Some kinds of flounder that live along coasts are also called soles (see FLOUNDER).



The European Sole Is a Famed Food Delicacy.

Scientific Classification. Soles make up the sole family, *Soleidae*. The American sole is genus *Trinectes*, species *T. manulatus*. The European sole is classified as genus *Solea*, species *S. vulgaris*. LEONARD P. SCHULTZ

SOLENODON, *soh LEE nuh dahn*, is a rare animal that looks like a long-nosed rat. The *yellow-headed solenodon* lives in Cuba and the *brown solenodon* makes its home in Haiti. The solenodon lives in hollow logs and rocky dens, and comes out for food only at night. It scratches for insects with its long claws. The solenodon weighs about 2½ pounds (1 kilogram) and grows about 2 feet (61 centimeters) long, including its stiff, scaly tail, which is 10 inches (25 centimeters) long. It has a long, pointed snout and short, coarse hair. The solenodon is bad tempered, and its saliva may be poisonous.

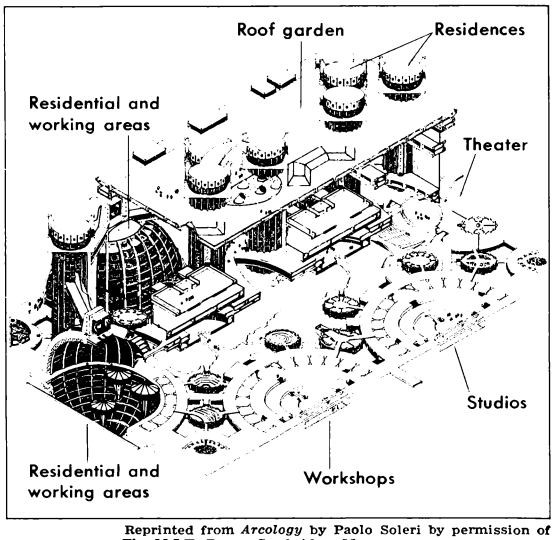
New York Zoological Society

The Rare Solenodon looks like a long-nosed rat. It is a shy animal, and rarely comes above ground in daylight hours.

Scientific Classification. The solenodon is in the solenodon family, *Solenodontidae*. The Haitian solenodon is genus *Solenodon*, species *S. paradoxus*. The Cuban solenodon is *S. cubanus*.

SOLERI, *soh LEH ree*, **PAOLO** (1919-), is an Italian-born architect and urban planner. He became famous for his theories of preserving the environment. Soleri believes that, to protect nature's resources, cities should be built on as little land as possible.

According to Soleri, an urban center should be a single structure surrounded by open land used for agriculture and recreation. He calls such a city an *arcology*, a term formed by combining parts of the words *archi-*



Reprinted from *Arcology* by Paolo Soleri by permission of The M.I.T. Press, Cambridge, Mass.

Soleri's Experimental Cities are designed on many vertical levels to save land. Soleri planned the community of Arcosanti, above, to occupy only a few acres in the Arizona desert. He believes that society must develop such communities to preserve the environment from rapidly growing metropolitan areas.

tecture and *ecology*. In 1970, Soleri began to build his first experimental city, called Arcosanti, near Prescott, Ariz. He designed Arcosanti for a population of 3,000.

Soleri has also designed other urban environments. As in Arcosanti, all housing, business, and industrial facilities would be located within a single gigantic structure. Such cities would use shuttle systems and moving walkways instead of automobiles. Nuclear and solar power would provide energy. Soleri's designs for these cities indicate his concern for pure geometric forms, and his strong faith in technology and machines.

Soleri was born in Turin, Italy. He moved to the United States in 1947 and settled in Arizona. There he built structures half hidden in the earth. He built some structures by forming the earth into a desired shape, pouring concrete over it, and then removing the earth to expose the interior space. DAVID GEBHARD

SOLFATARA. See VOLCANO (Products of Volcanic Eruption); FUMAROLE.

SOLICITOR. See LAWYER.

SOLICITOR GENERAL. See JUSTICE, DEPARTMENT OF; SUPREME COURT OF THE UNITED STATES (Pleading Cases).

SOLID, in mathematics, is a geometric figure with the three dimensions of length, breadth, and thickness. Some solids are named from the shapes of their surfaces, such as cubes, cylinders, cones, and spheres. In physics, solid refers to one of the three possible *states* (forms) in which matter may exist. The other states are *liquid* and *gaseous*. The state of each body of matter is classified according to the power of its molecules to resist forces that may change its shape. A solid has a fixed shape, weight, and volume. HOWARD S. KALTENBORN

Related Articles in WORLD BOOK include:

Cone	Gas	Prism
Cube	Liquid	Pyramid
Cylinder	Mensuration	Sphere

SOLID GEOMETRY. See GEOMETRY.

SOLID SOUTH. See RECONSTRUCTION.

SOLID STATE PHYSICS deals with the physical properties of solid materials. These properties include magnetism, *luminescence* (giving off light), mechanical strength, and the conduction of electricity and heat. Solid state physicists try to understand the properties of solids by studying the arrangement and motion of the atoms and electrons that make them up.

The atoms or molecules of most solids are arranged in a repeated pattern called *crystals* (see CRYSTAL AND CRYSTALLIZATION). The basic building block of a crystal is the *unit cell*, which is repeated over and over. Physicists beam electrons, X rays, or neutrons at crystals to learn how the atoms or molecules are arranged.

Much of the progress in solid state physics has been made by preparing extremely pure single crystals of various substances and studying their properties. The detailed structure of the electron distribution of a solid can be determined in this way. The information learned from such relatively ideal materials provides a better understanding of common materials and helps man create new materials with superior properties.

The field of solid state physics has grown rapidly since about 1946 because of its importance to industry and its scientific interest. More people are involved in it than in any other area of physics. Achievements of solid state physics include the development of transistors and other devices used in electronic circuits. Solid state physicists have also made *ferrites* (magnets that do not conduct electricity) used in the memory cores of computers, solid lasers, solar batteries, solid *luminescent sources* (devices that change electricity directly into light), and sensitive detectors for many types of radiation. The electrical, computer, communications, and space industries make use of solid state technology.

A knowledge of the *quantum theory* is essential in studying solid state physics. The theory forms the basis of understanding the structure of atoms and molecules and the forces that bind them together to form crystals.

Quantum theory has given an understanding of one of the most remarkable properties to be studied in solid state physics, *superconductivity*. In normal metals, voltage must be applied and power used to keep an electric current flowing. But in a superconductor, a current will flow indefinitely with no applied voltage. Superconductivity is exhibited by many metals and alloys at extremely low temperatures—for example, a few degrees above absolute zero (−273.15° C, or −459.67° F.).

Solid state physics is an expanding field of research with many other challenging problems. Some of the problems being studied involve the interaction of light from intense laser beams with matter. Other areas of research include the conversion of electrical energy into light, and improving materials for solid lasers and light sources. Methods of solid state physics are also being applied to the transfer of energy and electrical charge in organic systems important in biology. JOHN BARDEEN

See also SEMICONDUCTOR; TRANSISTOR; INTEGRATED CIRCUIT; QUANTUM MECHANICS; CRYOGENICS.

SOLÍS, JUAN DÍAZ DE. See RÍO DE LA PLATA; URUGUAY (Early Years).

SOLITAIRE, a bird. See DODO.

SOLITAIRE, *sahl uh TAIR,* is the name given to many card games that are played by only one person. Solitaire is usually played with 52 cards.

In one kind of solitaire, the player deals seven cards in a row, the first one face up and the rest face down. Then he deals a card face up on the second card, and a card face down on each of the remaining five. He continues until all seven piles have a card facing up.

One card may be placed on a second card if it is one lower in rank and is the opposite color of the second card. Aces rank lowest and are put in a row above the main piles. The object is to stack the cards by suits and in order in the top piles, from ace to king. The top card in any lower pile may be moved to this row if the card before it in the same suit is the last card in a pile. A face-down card that becomes the top card in a lower pile may be turned face up. The cards that were not dealt into piles are kept face down. Every third card is turned face up. LILLIAN FRANKEL

SOLITARY INSECT. See BEE (Solitary Bees); WASP (Solitary Wasps).

SOLOMON, the son of David, was the king under whom Israel reached its greatest prosperity and glory. Significantly enough, his name comes from *shalom,* a Hebrew word which means *peace.* His mother was Bathsheba, the woman whom King David fell in love with and married after her husband, Uriah, had died on the field of battle (see BATHSHEBA; DAVID). In the closing days of David's life, an older son, Adonijah, unsuccessfully attempted to gain recognition as his successor on the throne. But David had Solomon anointed as king in his place, and Adonijah had to flee for refuge.

Builds Temple. When Solomon felt secure upon his throne, he set out to accomplish the great task his father had not been allowed to perform, that of building the Temple of Jehovah. He went about this undertaking with reverence, desiring to set up a worthy sanctuary for the one true God. He wanted it to surpass in glory the idolatrous temples of the heathen. In the fourth year of his reign, about 966 B.C., he began building the temple (I Kings 6:1). He finished it in seven or eight years, and used gold and silver worth as much as $4 billion.

The greatest day in Solomon's life was the day of the service of worship when this magnificent temple was dedicated to the Lord (I Kings 8). Solomon stood on a great platform before the altar of the Lord, and led his people in prayer, begging God to meet with mercy and blessing all who should come to worship there. The Lord answered by sending down fire to enkindle the sacrifice on the altar, and by forming a "glory" cloud that signified His presence (II Chronicles 7:1).

His Wisdom. Solomon thus began his reign under most favorable circumstances and with the noblest of intentions. Soon after he had become king and before work started on the temple, he went up to the sanctuary at Gibeon to pray. When the Lord appeared to him in a dream and asked him to name whatever blessing he most desired, Solomon modestly requested only one thing: wisdom to know how best to govern his people and encourage them to lead a godly life, in obedience to the Law of Moses. God bestowed upon him not only wisdom, but also wealth, power, and victory over his enemies. He became so renowned that he excited the admiration of other countries. Some of their rulers, like the Queen of Sheba, came to see the glory and magnificence of which they had heard so much.

Solomon composed remarkable works on natural history and practical philosophy. He also wrote beautiful poetry, such as the Biblical book, Song of Solomon (see SONG OF SOLOMON). The book of Ecclesiastes and a large part of Proverbs are also attributed to Solomon.

His Downfall. The greatness of Solomon's success and prosperity led to his undoing. His unlimited power led to pride and self-indulgence. He filled his harem with wives and concubines. The Bible gives the total as about 1,000. He indulged their religious preferences by building pagan shrines at which they might carry on their worship. Starting with the Egyptian princess whom he honored above all his other wives, he allowed their image-worship. This paved the way for the deadly influence of idolatry upon the Hebrew nation. Solomon was also very proud of his chariotry and built huge stables in which to quarter his horses. His ships brought goods from India, southern Arabia, and Ethiopia.

But after a few decades the prosperity of Israel dwindled greatly. Economic hardship became widespread, despite an almost complete freedom from war and despite friendly relations with all the neighboring peoples. This economic hardship finally led to a revolt against high taxes and the system of forced labor which supported Solomon's extravagant building projects. His last years were embittered by personal disillusionment and by hostility at home and abroad. When Solomon died, his incompetent son, Rehoboam, could not hold the Hebrew empire together. The Ten Tribes broke away in successful rebellion and set up the Northern Kingdom of Ephraim, or Israel. GLEASON L. ARCHER, JR.

SOLOMON ISLANDS lie east of New Guinea in the southwestern Pacific Ocean. The northern Solomons include Bougainville, Buka, and a few smaller islands. They form part of the self-governing Australian territory of Papua New Guinea. They cover 4,200 square miles (10,878 square kilometers) and have a population of 73,276. The southern Solomons make up the British Solomon Islands Protectorate. They include Guadalcanal, Santa Isabel, San Cristóbal, Malaita, and Choiseul. They cover 10,983 square miles (28,446 square kilometers) and have a population of 181,000.

The islands' climate is hot, damp, and unhealthful. The islands have many active volcanoes. The highest peak is Mt. Balbi (10,170 feet, or 3,100 meters) on Bougainville. The islands' crops include bananas, coconuts, pineapples, rubber, sweet potatoes, and taro. Exports include copra, ivory nuts, shells, and timber.

Most of the people are dark-skinned Melanesians. Polynesians, Chinese, and Europeans also live there.

In 1568, Álvaro de Mendaña of Spain became the first European to reach the Solomons. He named them in the belief that he had found the source of the gold used for Solomon's Temple in Jerusalem. Later expeditions could not find the islands. Philip Carteret of England finally found them again in 1767.

Germany occupied the northern Solomons from the 1880's until 1900, when it transferred all but Bougainville to Britain. The southern Solomons became a British protectorate in 1893. Early in 1942, the Japanese seized most of the islands, and they became a bitterly contested area of World War II. United States

troops finally took the islands from the Japanese after heavy fighting in 1942 and 1943. GEORGE F. DEASY

See also BOUGAINVILLE; GUADALCANAL ISLAND; PACIFIC ISLANDS (map).

SOLOMON'S-SEAL is a hardy plant that grows in the temperate zones of North America, Europe, and Asia. Several closely related plants have this name. It gets its name from its thick, creeping rootstalks which bear growth scars that resemble the mystic seal of Solomon.

The plant has a long, arching stem that gives it a graceful appearance. It bears round berries that may be blue or black. Greenish, bell-shaped flowers grow at the bases of the leaves. Solomon's-seal grows best in shady places and rich, moist soil.

Scientific Classification. Solomon's-seal belongs to the lily family, *Liliaceae*. It is genus *Polygonatum*. EARL L. CORE

SOLON, *SOH lahn* (639?-559? B.C.), was a famous lawmaker. He was known as one of the *seven wise men of Greece*.

Solon was born in Athens of a noble family. He first became known as a poet. His poems played a great part in urging the Athenians to regain the island of Salamis, which had long been in foreign hands. He was given command of the forces sent to take back the island, and he quickly conquered it. Afterward, Solon was elected an *archon* (chief government official) of Athens and was given authority to change the laws (see ARCHON).

Athens was badly in need of political and economic reforms. Most of the wealth was in the hands of a few powerful citizens. The farmers had been forced to mortgage their lands and to borrow money, offering themselves and their families as security. Solon immediately passed a law which canceled all these debts and mortgages, and freed those who had become slaves. He also changed the monetary system so that foreign trade was made easier. The only change Solon made in foreign trade was a law prohibiting the exportation of grain.

Solon's constitutional reforms redivided the citizens into four classes, according to income. Citizens of all classes were allowed to become members of the assembly and the public law courts. Solon established a council of 400 to take over the political powers of the Areopagus, and set up popular courts in which citizens could appeal the decisions of the officials (see AREOPAGUS). He kept the old provisions that allowed only the three higher classes to hold public office, and only the highest class to hold the archonship. These provisions continued the oligarchy, but his reforms were a definite step toward democracy.

Solon is said to have made the Athenians promise to keep his laws for 10 years. He then left the state. When he returned 10 years later, he found the country fighting a civil war. Soon afterward, Pisistratus seized control. After opposing Pisistratus, Solon retired from public life. DONALD KAGAN

SOLSTICE, *SAHL stihs*, is the sun's direction in space when it appears at its farthest point north or south among the stars. Two solstices occur each year. In the Northern Hemisphere, the summer solstice is about June 21, and the winter solstice is about December 22. The solstices are reversed in the Southern Hemisphere.

The sun appears to move north and south among the stars. This happens because the earth's axis stays tilted toward a certain direction in space as the earth revolves around the sun. As a result, the Northern Hemisphere gradually slants toward the sun for half the year and then gradually slants away for the other half. As the North Pole slants increasingly toward the sun, the sun appears to move farther north among the stars.

When the summer solstice occurs in the Northern Hemisphere, the North Pole slants most directly toward the sun. This day is usually, but not always, the longest of the year in that hemisphere. The winter solstice in the Northern Hemisphere occurs when the North Pole slants most directly away from the sun. ERIC D. CARLSON

See also SEASON; EQUINOX.

SOLTI, *SHOHL tee*, **SIR GEORG** (1912-), is a leading symphony orchestra and opera conductor. He has won fame for his interpretations of romantic works, especially the symphonies of Anton Bruckner and Gustav Mahler and the operas of Richard Wagner.

Solti was born in Budapest, Hungary. He worked at the Budapest Opera House from 1930 until World War II began in 1939. From that year until the war ended in 1945, he lived in Switzerland. Solti worked in Germany from 1946 to 1960. He served as music director of the Munich State Opera until 1952, when he was named conductor of the Frankfurt Opera. Solti became conductor of the Royal Opera House in London in 1961 and music director of the Chicago Symphony Orchestra in 1969. He became a British subject in 1971 and was knighted in 1972. KEITH POLK

SOLUBLE GLASS. See WATER GLASS.

SOLUTION is a mixture of substances that cannot be separated by mechanical methods, such as filtration. Blood plasma, a mixture of water, salts, and proteins, is a solution in the body. Salt water is a natural solution that fills the oceans. A solution may be a liquid, a solid, or a gas.

Liquid solutions result when a liquid dissolves another liquid, or a solid or a gas. Two liquids that can form a solution are said to be *miscible*. This ability depends on the chemical properties of the liquids, and on such physical conditions as temperature and pressure. Most oils are only slightly miscible with water at room temperature. But they become more miscible when they are heated.

Gases and solids that dissolve in a liquid are said to be *soluble*. This ability also depends on the chemical properties of the substances, and on physical conditions. As the temperature of a liquid solution rises, dissolved gases usually become less soluble. But dissolved solids usually become more soluble. Soft-drink manufacturers dissolve carbon dioxide gas in water under pressure. When a soft-drink bottle is opened, this pressure is released. The carbon dioxide gas then becomes less soluble, and part of it bubbles away. Pressure changes usually have little effect on the solubility of a solid.

Solid solutions are formed when liquid solutions freeze. For example, when a solution of melted copper and zinc freezes, it forms a solid solution called *brass*. Steel is a solid solution that results when various metals and nonmetals are dissolved in iron. The melting point of a solid solution usually differs from that of its parts.

Gaseous solutions can be made from any combination of gases. Air is a gaseous solution. The most abundant gases in air are nitrogen, oxygen, argon, carbon dioxide,

and water vapor. The ability of gases to form a solution is not affected by their chemical properties or by physical conditions. JOHN P. FACKLER, JR.

See also SOLVENT.

SOLUTION SET. See SET THEORY (In Algebra).

SOLVENT is a liquid that dissolves another substance and forms a solution. Water is the most common solvent. It dissolves a great many substances, including sugar, salt, alcohol, and air. Turpentine, another common solvent, is used to wash oil-base paints out of paint brushes. Each year, chemists develop many new solvents to meet specific needs.

The substance that dissolves in a solvent is called the *solute*. A solute may be a solid, a liquid, or a gas.

In a solution of two or more liquids, the most abundant liquid is called the solvent. For example, vinegar consists mainly of water and acetic acid. This solution contains more water than acetic acid, so water is called the solvent. The acetic acid is called the solute.

A solvent that has dissolved as much solute as possible is said to be *saturated*. For example, when water has dissolved so much salt that additional salt cannot be dissolved, the water is said to be saturated with salt. The amount of solute that a solvent can dissolve depends on the chemical properties of both substances. It also depends on such conditions as temperature and pressure. JOHN P. FACKLER, JR.

Related Articles in WORLD BOOK include:

Acetone	Chloroform	Solution
Alcohol	Furfural	Turpentine
Carbon Disulfide	Paint	

SOLYMAN. See SULEIMAN I.

SOLZHENITSYN, *sahl zheh NEE tsihn*, **ALEXANDER** (1918-), is a Russian novelist. He was awarded the 1970 Nobel prize for literature.

Alexander Isaevich Solzhenitsyn was born in Kislovodsk. He served four years in the Soviet Army during World War II. In 1945, while still in the army, Solzhenitsyn was falsely accused of a political crime. He was arrested and spent eight years in labor camps and three years in exile.

Solzhenitsyn's novels reflect his prison and war experiences. *One Day in the Life of Ivan Denisovich* (1962) and *The First Circle* (1964) have prison settings. *Cancer Ward* (1966) takes place in a hospital. Using the prison and the hospital as symbols of society, the author dramatizes the contrast between revolutionary ideals and harsh political reality. His heroes express the triumph of human dignity over tyranny and suffering.

Solzhenitsyn has also written a historical novel, *August 1914* (1971). The book describes the Russian army's defeat by the Germans at the Battle of Tannenberg in the opening weeks of World War I.

Throughout the 1960's and early 1970's, the Soviet government accused Solzhenitsyn of slandering his country in his writings. The government intensified its attacks on the author following the publication in Paris of Solzhenitsyn's *The Gulag Archipelago, 1918-1956* in December, 1973. This book is a study of the Soviet prison camp system. In February, 1974, the government revoked Solzhenitsyn's citizenship and deported him. He settled in Switzerland. THOMPSON BRADLEY

SOMA. See GERM CELL.

SOMALIA

WORLD BOOK map

SOMALIA, *soh MAH lee uh*, is the easternmost country in Africa. It stretches along Africa's "horn," facing the Gulf of Aden and the Indian Ocean. Somalia is a little smaller than Texas and has about one-fourth as many people as that state. Most Somalis are herdsmen who wander over the hot, dry land in search of water and pasture. Somalia has few towns. Mogadiscio, which has about 172,680 persons, is the capital and largest town.

Wild animals are plentiful in Somalia. Antelope, cheetahs, and lions roam the grasslands. Crocodiles swim in the country's main rivers, and elephants and hippopotamuses live in the forests along the riverbanks.

Somalia consists of two regions that were once called British Somaliland and Italian Somaliland. These colonies became independent in 1960, and combined to form the SOMALI REPUBLIC. In late 1969, the country was renamed the SOMALI DEMOCRATIC REPUBLIC.

I. M. Lewis, the contributor of this article, is Professor of Anthropology at the London School of Economics, London, England. He is the author of The Modern History of Somaliland *and* Peoples of the Horn of Africa.

Government. Somalia is a republic. In October, 1969, a group of army and police officers seized control of the government. They suspended the constitution and set up a Supreme Revolutionary Council to rule the country. The council dissolved the Cabinet and the National Assembly. It also abolished all political parties and set up regional and district revolutionary councils. Civilian district officials were replaced by army officers.

People. More than 75 per cent of the Somalis are nomads who raise herds of camels, cattle, goats, and sheep. The others live on farms or in Somalia's few towns. Almost all the people are Moslems of the Sunnite branch of Islam. They claim to be related to Mohammed, the founder of Islam. See ISLAM.

The nomads roam over vast stretches of their hot, dry land in search of water and pasture for their herds. Their hard life leaves little time for relaxation. When water and pasture are plentiful, however, they enjoy telling stories and holding poetry contests in the evening around a campfire. They recite long poems about major events, such as battles and victories, or in praise of prized possessions such as camels and horses.

The nomads live in small, collapsible, beehive-shaped huts that have arched wooden braces covered with skins and grass mats. When the grass and water are used up in one spot, they pack their huts and move to a new spot. Their chief food is milk, especially camel's milk. They eat rice and other grains, and mutton. In southern parts of Somalia, the people roast coffee beans in butter oil and eat them boiling hot with milk. They believe that it is healthful to inhale the hot fumes of the oil and to rub the oil over their arms and hair.

The men and women wrap brightly colored cloth or cotton sheeting around their bodies like a toga. Many of the men wear the *lungi*, a kind of kilt. Many who live in the towns wear trousers and shirts.

Before 1973, Arabic, English, and Italian were the official languages of Somalia. Somali, a language spoken by most of the people, had no standard written form. But in 1973, the government adopted a written form and declared Somali the official language. In the early 1970's, less than a tenth of all Somalis could read and write. In 1974, the government temporarily closed most of the country's schools. Teachers and students were sent into the countryside to teach the nomads to read and write. The National University of Somalia, the country's only university, is in Mogadiscio.

The Somalis band together in large groups of relatives whose relationships are traced through the men. If members of one group kill or injure a member of another, the attackers' group must pay the victim's group. A man's life is valued at 100 camels, and a woman's at 50. Payment may also be in money.

Land. Narrow plains line the coast in northern Somalia. Behind them, mountains rise nearly 8,000 feet (2,400 meters) above sea level. Farther inland lie high plateaus covered with rich pasture after rainy seasons, and dry plains of thorn bush and tall grasses.

Wide coastal plains in the southern half of Somalia rise gradually toward the west to a plateau cut by plains and valleys. The most important valleys are those of the Giuba and Scebeli rivers, the only rivers in Somalia that have water all year. Forests line the river banks. Somalia's richest farmland lies between the two rivers. Dry plains cover the rest of the region.

Somalia has an average year-round temperature of 80° F. (27° C). In June and July, the temperature rises to 115° F. (46° C) on the northern coastal plains. That region, the driest in Somalia, receives 2 to 3 inches (5 to 8 centimeters) of rain a year. The southern farmlands receive about 20 inches (51 centimeters).

Economy. Somalia is an underdeveloped agricultural country. Bananas, hides and skins, and livestock are its chief products, and make up about 90 per cent of the exports. Some sorghum and other grains are grown, but large amounts must be imported. There is little

FACTS IN BRIEF

Capital: Mogadiscio.

Official Language: Somali.

Form of Government: Republic.

Head of State: President of the Supreme Revolutionary Council.

Area: 246,201 sq. mi. (637,657 km²). *Greatest Distances*—north-south, 950 mi. (1,529 km); east-west, 730 mi. (1,175 km). *Coastline*—1,837 mi. (2,956 km).

Elevation: *Highest*—Mount Surud Ad, 7,894 ft. (2,406 m) above sea level. *Lowest*—sea level along the coast.

Population: *Estimated 1976 Population*—3,221,000; distribution, 79 per cent rural, 21 per cent urban; density, 13 persons per sq. mi. (5 persons per km²). *Estimated 1981 Population*—3,609,000.

Chief Products: *Agriculture*—bananas, grains, hides and skins, livestock, milk, sugar cane. *Manufacturing*—processed foods.

Flag: The light blue flag has a large white star in the center. The colors come from the United Nations flag. See FLAG (color picture: Flags of Africa).

Money: *Basic Unit*—shilling. See MONEY (table: Values).

Authenticated News Int.

Mogadiscio, the Capital of Somalia, has buildings of the Islamic architectural style along its main street, above.

manufacturing. Somalia's minerals, including rich deposits of iron ore and gypsum, have not been mined.

Somalia has no railroads, and only about 450 miles (724 kilometers) of its 9,000 miles (14,000 kilometers) of roads are surfaced. Somali Airlines operates domestic and international flights.

The government operates radio stations in Mogadiscio and Hargeisa. Somalia has a few small newspapers.

History. Ancestors of the Somalis began migrating from what is now northern Somalia to the south in the 800's and 900's. They were converted to Islam by Arabs who had settled on the coast. The Arabs and Somalis fought many religious wars against the Christian kingdom of Ethiopia between the 1300's and 1500's.

Europeans began to colonize the Somali regions during the mid-1800's. France developed a colony in what is now the French Territory of Afars and Issas in the 1860's. The British took over what later became British Somaliland (now northern Somalia) in 1884. In 1889, Italy established control in what is now southern Somalia. During the 1890's, Ethiopian armies seized the Ogaden, a Somali territory west of the British and Italian colonies. The Somalis revolted in 1900, but the British crushed the revolt in 1920.

Italian forces conquered Ethiopia in 1936, and joined it to Italian Somaliland. In 1940, during World War II, Italy also seized British Somaliland. But the British drove the Italians from eastern Africa in 1941. The British returned the Ogaden to Ethiopia in 1948. In 1950, the United Nations gave Italy its former colony as a trust territory for 10 years, during which Italy agreed to prepare it for independence. By that time, the Somali movement to unite all Somali regions was well established. But in 1955, the British turned over another area, a huge grazing region called the Haud, to Ethiopia.

The British granted British Somaliland independence on June 26, 1960. On July 1, Italian Somalia also became independent, and the two regions combined to form the Somali Republic. But many Somali people were living in eastern Ethiopia, northern Kenya, and French Somaliland (now the French Territory of Afars and Issas). Somali leaders claimed that these Somalis should also have the right to decide what form of government they wanted. As a result, Somalia's relations with its neighbors became tense in the early 1960's. Border fighting with both Ethiopia and Kenya broke out frequently.

In 1969, Somalia's president was assassinated. A military group then took control of Somalia. During the 1970's, the government began widespread health and literacy campaigns, roadbuilding projects, and other programs. I. M. Lewis

See also Clothing (picture: Traditional Costumes); Hargeisa; Mogadiscio.

SOMALILAND, *soh MAH lee LAND*, is the name of a large region along the eastern coast of Africa, inhabited by Somali tribes. These tribes live in Somalia, the French Territory of Afars and Issas, northeastern Kenya, and eastern Ethiopia. The region covers 400,000 square miles (1,035,995 square kilometers). Somaliland has 4,581,040 people. See also Somalia; French Territory of Afars and Issas. R. J. Harrison Church

SOMALILAND, FRENCH. See French Territory of Afars and Issas.

SOMBRERO. See Mexico (Clothing).

SOMERSET. See England (political map).

SOMERSET, DUKE OF. See Edward (VI).

SOMERVILLE, Mass. (pop. 88,779), is an industrial suburb of Boston (see Massachusetts [political map]). It was first settled in 1630 as part of Charlestown. Prospect Hill, one of the city's seven hills, became an important observation post during the American siege of Boston in the Revolutionary War. The first U.S. flag with 13 stripes was raised on Prospect Hill in 1776.

Somerville became a town in 1842, and a city in 1871. It has a mayor-council government. William J. Reid

SOMME RIVER, *sawm*. Great battles of World Wars I and II were fought along this stream in northern France. The river rises near the Belgian border, and flows west for 140 miles (225 kilometers) to the English Channel. For location, see France (physical map). Ocean steamers enter the port of Saint Valéry through the mouth of the Somme. A canal runs beside the Somme from Saint Valéry to Saint Quentin. From Saint Quentin, canals connect with the Oise and Schelde rivers. Edward W. Fox

SOMNAMBULISM. See Sleepwalking.

SOMNUS was the god of sleep in Roman mythology. The Greeks called him Hypnos. He was the son of Erebus and Nyx, the goddess of night. His brother was Mors, the god of death, whom the Greeks called Thanatos. Somnus' son was Morpheus, god of dreams (see Morpheus). Somnus and Mors lived in a great cave. The river Lethe flowed nearby, and its gentle murmuring invited sleep. Everything in the dimly lit cave slept. The forms of pleasant dreams floated about, and dark nightmares hid in the cave. James F. Cronin

SOMOZA, *suh MOH zuh*, is the family name of three Nicaraguan dictators, a father and his two sons. The Somozas have dominated the social, economic, and political life of Nicaragua since the 1930's.

Anastasio Somoza García (1896-1956) ruled Nicaragua for 20 years before he was killed by an assassin. He crushed all opposition and did not allow freedom of expression. He also used his power to become rich.

Somoza was born in San Marcos, Nicaragua, the son of a small rancher. He studied at Peirce Union Business College (now Peirce Junior College) in Philadelphia, then returned to Nicaragua, and became a tax collector. He joined a revolutionary movement led by his wife's uncle, Juan Batista Sacasa. Somoza became minister of war in 1932, after Sacasa was elected president.

In 1934, Somoza gained a reputation as a feared and ruthless man when he ordered Augusto Sandino, a popular guerrilla fighter, killed by the National Guard. In 1936, Somoza drove Sacasa from power. Somoza was elected president later that year in an election controlled by his troops. Somoza resigned as president in 1947, but he forced his successors to rule as he wished. He was elected president again in 1950.

Somoza improved Nicaragua's agriculture, cattle raising, and mining. He balanced the budget and introduced easier credit for farmers. He also expanded port facilities and built new highways, houses, hospitals, power plants, railroads, and schools.

Luis Somoza Debayle (1922-1967) became president of Nicaragua after his father was killed, and served until 1963. He tried to bring about social reforms and loosen

the tight military control of Nicaragua. One of his reform laws prevented any member of his family from succeeding him. But the Somoza family hand-picked the man who was elected to succeed him as president. Luis Somoza Debayle was born in León, Nicaragua.

Anastasio Somoza Debayle (1925-) served as president of Nicaragua from 1967 to 1972 and was elected to that office again in 1974. He ruled as a dictator, controlling the military services and the economy as his father did. He was born in León. He graduated from the U.S. Military Academy, and headed the National Guard during his father's second term and his brother's administration. THOMAS G. MATHEWS

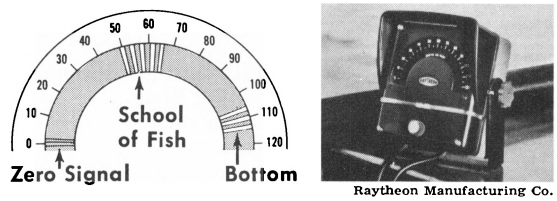
See also NICARAGUA (Government; History).

SONAR is a detecting device that uses sound. The term sonar is made up from the words **so**und **n**avigation **a**nd **r**anging. There are two types of sonars. One type is used in navigation to find the water depth. Warships and military aircraft use the other type of sonar to find submarines, and then attack and destroy them.

Both types of sonars operate on the same principle. They send out a sound wave into the water. When the wave meets an object, it reflects back. The distance to the object is found by measuring the time taken by the sound wave to return. This is called *echo ranging*. Sonars and radars are echo-ranging devices. See RADAR.

How Sonar Works. Sonars generally use sound frequencies of 5,000 to 25,000 hertz. The signals are generated in a *transmitter* within the ship. They are sent to a *transducer*, an antennalike device in the water under the ship. The transducer changes the electrical signals to sound waves and sends them through the water. The waves travel outward or downward until they strike an object and reflect back to the transducer. As the signal is sent out, part of it is routed within the ship to a *receiver* and *indicator*, which resembles an electric stop watch. It marks zero time as it receives a signal that sound waves are being sent out. It then begins to keep time. As the waves return from an object, they are changed by the transducer to electric signals, which again are sent to the indicator. When it receives these signals, it indicates the range. Since sound travels in water at about 1,600 yards (1,460 meters) each second, the indicator can give the distance in yards. Depth-finding equipment gives the distance in fathoms.

History. At first, all ranging devices were built on a "searchlight" principle. The transducer was moved back and forth like a searchlight to catch the sound waves. As the "searchlight" crossed the target, the bearing could be measured and ranges recorded. But it takes a long time to search through a circle with such a device. During World War II, it was learned that a cylinder could be built of *staves* (sections), each of which was a transducer. Sound waves could be sent in all directions. The electronic circuits were devised to scan two or more sections of the transducer, forming their signals into a beam. The result was a scanning sonar with electronic beam rotation which can be used for rapid search.



Raytheon Manufacturing Co.

Sonar is a depth-sounding instrument. It beams short bursts of sonic energy toward the ocean bottom. The sonic receiver picks up echoes from the bottom, from fish, or from other objects. An indicator, above, shows at what depth these features are located.

Natural Sonar. Some animals find direction by means of echo sounding. For example, bats make *ultrasonic* (high-frequency) squeaks that bounce back from obstacles. See BAT; DOLPHIN. RAWSON BENNETT

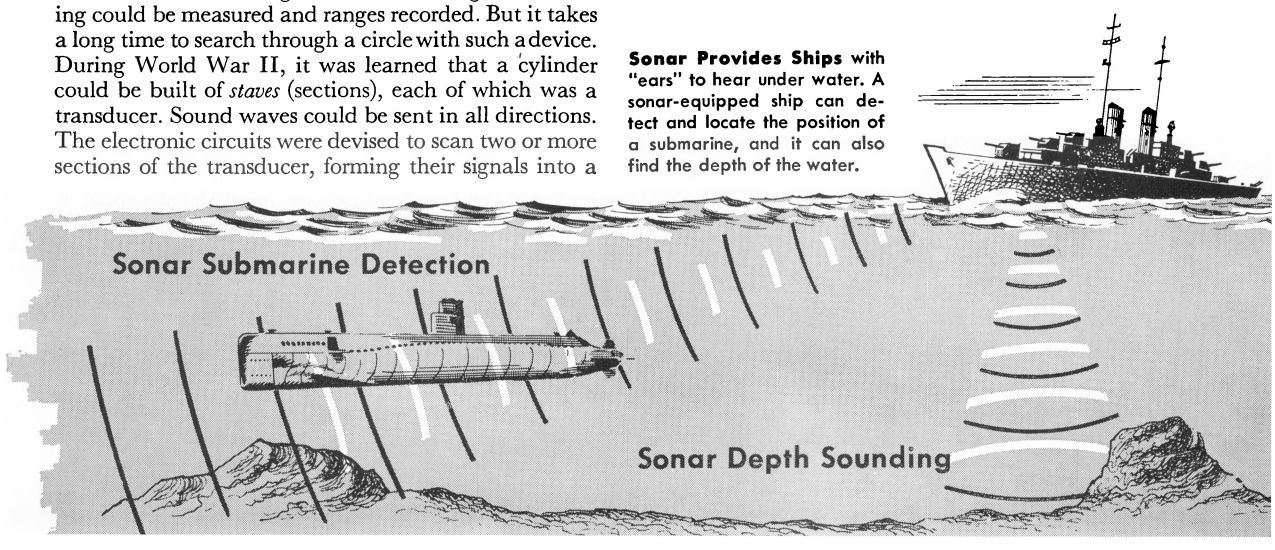
SONATA, *soh NAH tuh*, is an instrumental composition with three or four movements with contrasts both in tempo and key, but related in thought. The usual four-movement sonata begins with a brilliant *allegro*, and the second movement is slow, rhythmic, and lyrical (*andante*, *adagio*, or *largo*). The third movement is usually light and graceful, and may be in dance form, or a *scherzo*. The *finale* (last movement) is in quick, bright tempo. Symphonies, string quartets, and long works for solo instruments use this sonata form. The first movement of the sonata is called the *sonata-allegro* form. It has three sections called the *exposition*, the *development*, and the *recapitulation*, which is almost a repetition of the exposition, but usually shorter. RAYMOND KENDALL

SONG. In music, there are two types of song: *folk songs* by unknown artists, and *art songs*, musical settings of poetic texts. In the Middle Ages, English bards, German minnesingers, Scandinavian skalds, and French troubadours sang of brave deeds, the gods, and love. Later, composers set beautiful poems to music. The rise of opera in the 1600's tended to slow the development of the more lyric song. The lyric song persisted in Germany, and was developed in the 1800's by Franz Schubert, Robert Schumann, and Johannes Brahms.

Related Articles. See SINGING with its list of Related Articles. See also the following articles in WORLD BOOK:

Berceuse	Chantey	Lieder	Popular Music
Canon	Folk Music	Lullaby	Round
Carol	Hymn	Madrigal	Spiritual

Sonar Provides Ships with "ears" to hear under water. A sonar-equipped ship can detect and locate the position of a submarine, and it can also find the depth of the water.



SONG OF BIRDS. See BIRD (Bird Songs); also names of specific birds such as BLACKBIRD; ROBIN.

SONG OF DEBORAH. See DEBORAH.

SONG OF ROLAND. See ROLAND.

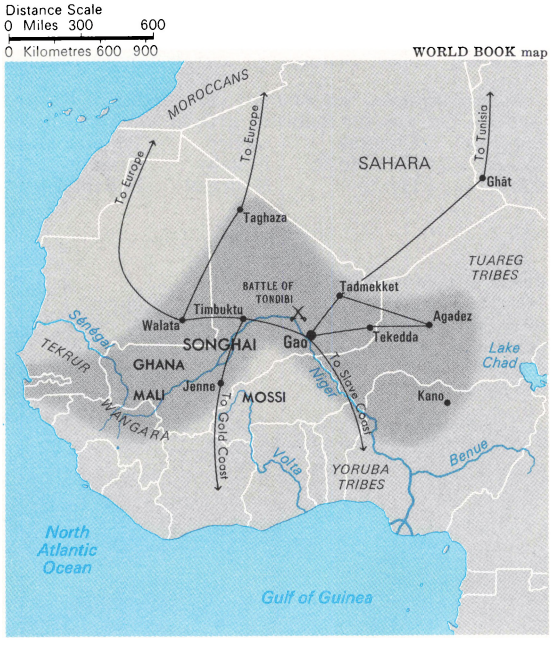
SONG OF SOLOMON is the name of a poetic book in the Old Testament. The book is also called the *Song of Songs* and *Canticles*. For hundreds of years, most persons considered it an allegory that showed God's love for His children by means of a description of human love. Many Jews saw in it the love of God for the people of Israel. Many Christians found in it the love of Christ for the church. Some persons still accept these allegorical interpretations. But most scholars today interpret the book literally. Some consider it a poetic drama whose characters include a girl, her shepherd lover, and King Solomon. Others suggest that the songs were originally part of a pagan spring festival, and were later changed so that they could be included in the Bible. Many scholars regard the book as a collection of love and nature songs written in ancient Israel. ROBERT GORDIS

SONG OF THE LARK. See BRETON, JULES ADOLPHE.

SONGHAI EMPIRE was a Negro trading state in Africa that reached the height of its power during the 1400's and 1500's. Songhai began in the 700's, and by the 1400's it had more power and wealth than any other West African empire. Songhai extended from the central area of what is now Nigeria to the Atlantic coast and included parts of what are now Gambia, Guinea, Mali, Mauritania, Niger, Senegal, and Upper Volta.

THE SONGHAI EMPIRE ABOUT 1500

This map shows in dark gray the Songhai Empire at the height of its power. During the reign of Emperor Askia Mohammed, the empire stretched from the Atlantic coast to what is now central Nigeria. The Songhai controlled important trade routes that made the empire the richest in West Africa. The white lines are the boundaries of present-day countries.



Gao, the capital, stood on the Niger River (see GAO).

Songhai became powerful chiefly by controlling trade across the Sahara. Most of Songhai's people were farmers, fishermen, or traders. The traders exchanged gold and other West African products for goods from Europe and the Middle East.

Two kings, Sunni Ali and Askia Mohammed, strengthened the empire more than any other rulers. Sunni Ali ruled from 1464 until 1492 and began a unified system of law and order, central government, and trade. His army conquered Timbuktu and Jenne, two West African trading centers (see JENNE; TIMBUKTU).

Askia Mohammed, also known as Askia I or Askia the Great, became king in 1493. The empire reached its peak under his rule. Askia reorganized the Songhai government, expanded trade, and encouraged the people to practice Islam, the religion of the Moslems. Askia's three sons deposed him in 1528. The empire ended in 1591 when a Moroccan army defeated the Songhai in the Battle of Tondibi. LEO SPITZER

See also ASKIA MOHAMMED; SUNNI ALI; WALATA.

SONIC BOOM is a loud noise caused by an airplane flying at a supersonic speed. To a person on the ground, it may sound like a clap of thunder. The noise results from a shock wave produced by the plane.

A shock wave is a pressure disturbance that builds up around a plane flying at a supersonic speed. The disturbance results from a change in the air-flow pattern around the plane's leading edges. Sonic booms cannot hurt people, but they may damage plaster walls and break windows.

A plane reaching the speed of sound is said to be crossing the *sound*, or *sonic*, *barrier*. Captain Charles E. Yeager of the U.S. Air Force became the first person to break the barrier. He did so in a Bell X-1 rocket plane on Oct. 14, 1947. ROBERT D. ROACH, JR.

See also AERODYNAMICS (Shock Waves and Sonic Booms); YEAGER, CHARLES ELWOOD.

SONNET is a poem of 14 lines with a fixed pattern of meter and rhyme. Its name is an Italian word meaning *a little song*. In the Italian sonnet, the *octave* (the first eight lines) states a theme or experience and the *sestet* (the final six lines) responds to or comments on the theme. The octave rhyme scheme is *abbaabba* (lines one, four, five, and eight rhyme; and lines two, three, six, and seven rhyme). The sestet often rhymes *cdecde*.

During the Italian Renaissance (the A.D. 1200's and 1300's), poets wrote groups of love poems called *sonnet sequences* in this form. Dante addressed sonnets to Beatrice, Petrarch to Laura. The French court poet, Pierre de Ronsard, wrote *Sonnets for Hélène* (1578).

English poets brought back this form from their travels abroad. Sonnets by Sir Thomas Wyatt and Henry Howard, Earl of Surrey, were published in *Tottel's Miscellany* (1557). For his *Amoretti* (1595), Edmund Spenser invented his own rhyme scheme. But the form used by William Shakespeare has been accepted as typically English. It consists of three *quatrains* (four-line stanzas) followed by a *couplet* (two-line stanza), rhyming *abab cdcd efef gg*. By the time Shakespeare's *Sonnets* was published in 1609, the writing of sonnet sequences already was out of fashion.

Few sonnets were written in English during the next 200 years. But in the mid-1600's, John Milton wrote a few great sonnets, including "On His Blindness"

(1655). The form was revived during the Romantic period (1798-1832). An example is John Keats' "On First Looking into Chapman's Homer" (1816). Later in the 1800's, Elizabeth Barrett Browning wrote love poems to her husband in the sequence *Sonnets from the Portuguese*. Edna St. Vincent Millay is the best known of recent American poets to write in this exacting and compressed poetic form. CHARLES W. COOPER

See also SHAKESPEARE, WILLIAM (Sonnets); POETRY (What Makes a Poem Great?).

SONOMETER, *so NAHM ee ter,* is an instrument used to study the mathematical relations of musical tones. The sonometer, sometimes known as the *monochord,* consists of a tightly stretched string, one end of which passes over a pulley wheel. When plucked, the string vibrates and thus produces sound. The *frequency* (number of vibrations a second) of the tone is increased if the string is made shorter or tighter. RICHARD H. BOLT

SONORA, *soh NOH ruh,* a state in northwestern Mexico, borders the United States (see MEXICO [political map]). Sonora has an area of 71,403 square miles (184,933 square kilometers), and a population of 1,198,720. Its mountains contain rich deposits of copper, lead, graphite, and some silver. Farmers in the river valleys grow rice, wheat, chick-peas, tomatoes, vegetables, and cotton. Sonora became a state in 1830. Hermosillo is the capital and largest city. CHARLES C. CUMBERLAND

SONS OF LIBERTY was a group of patriotic societies that sprang up in the American colonies before the Revolutionary War. The Sons of Liberty groups began as secret societies, but later came into the open. They fought against the Stamp Tax of 1765. They opposed the importation of British goods after the passage of the Townshend Acts, and later began to demand national independence. They helped other independence moves, including the calling of the Continental Congress.

During the Civil War, a group of men known as *Copperheads* began to call themselves the *Sons of Liberty.* They were Northern sympathizers with the South, and planned to overthrow the Lincoln Government. Their plots were discovered and suppressed. JOHN R. ALDEN

See also COPPERHEAD (nickname).

SONS OF SAINT GEORGE. See GEORGE, SAINT.

SONS OF SAINT TAMMANY. See TAMMANY, SOCIETY OF.

SONS OF THE AMERICAN REVOLUTION is a patriotic organization. Its members are male descendants of persons who served in the Revolutionary War, or who contributed toward establishing the independence of the United States. The society is dedicated to perpetuating American ideals and traditions, and to protecting the Constitution. Constitution Day, Flag Day, and Bill of Rights Day were established through its efforts. The society was founded on April 30, 1889. Its official name is National Society of the Sons of the American Revolution. It has about 20,000 members in the United States and France. The society has national headquarters at 2412 Massachusetts Avenue NW, Washington, D.C. 20008. Critically reviewed by the SONS OF THE AMERICAN REVOLUTION

SONS OF UNION VETERANS OF THE CIVIL WAR is an American patriotic society. It was founded in 1881, and incorporated in 1954. Its 3,000 members are men 16 years of age or older who are descendants of Union veterans of the Civil War. Headquarters are in Gettysburg, Pa. The Daughters of Union Veterans of the Civil War is a similar organization for women. It has headquarters at 503 S. Walnut Street, Springfield, Ill. 62704. H. H. HAMMER

SOO CANALS, also called SAULT SAINTE MARIE CANALS, permit ships to pass between Lakes Superior and Huron. These canals are located on the United States-Canadian border (see MICHIGAN [political map]).

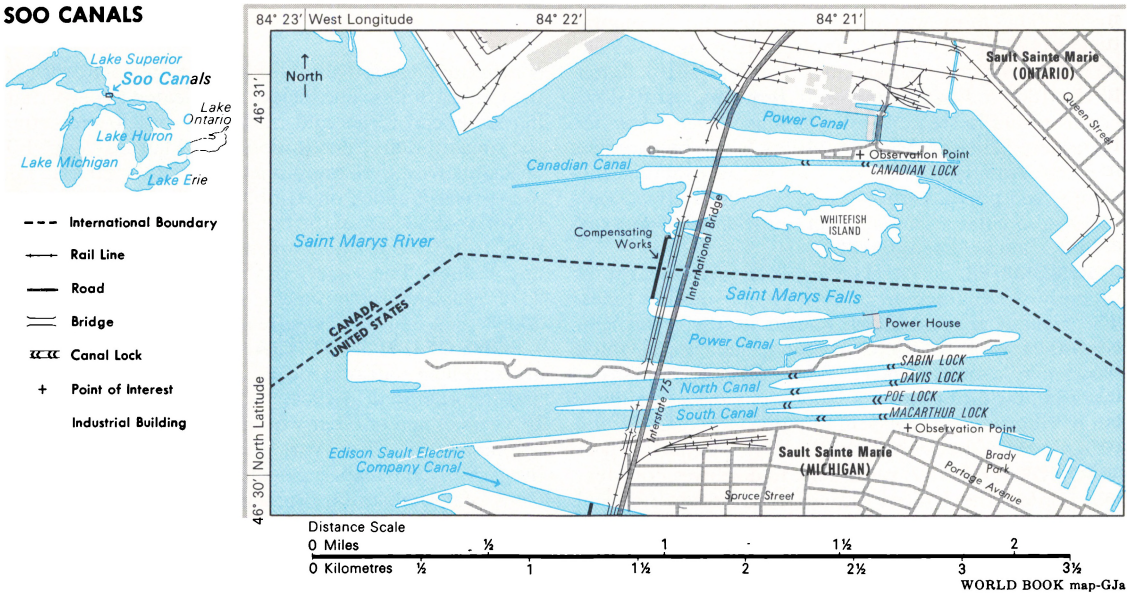
About 85 to 90 per cent of the tonnage on the canals is eastbound. Iron ore and grain make up most of the eastbound cargo. Coal, stone, and oil are the chief products carried on westbound ships. More than 100 million short tons (91 million metric tons) of cargo pass through these canals annually. In the early 1970's, the total tonnage shipped through them was about three-fourths as much as the cargo tonnage shipped through the Panama Canal. Ice closes the Soo Canals from about mid-November to early April.

The Saint Marys River forms a natural connection between lakes Superior and Huron. Early trappers sometimes "ran the rapids" to cross from one lake to the other. However, they usually carried their canoes and furs around the rough water. In 1798, the Hudson's Bay Company completed a canal with a single lock that permitted canoes and flat-bottomed boats to pass up the river. American troops destroyed the lock during the War of 1812. After 1839, ships were moved around the rapids on rollers. A railroad was built in 1850.

The American Canals. Increasing shipments of iron and copper during the late 1800's created a need for

Jarrett, APF

The Soo Canals, on the United States-Canadian border, rank among the busiest ship canals in the Western Hemisphere. The International Bridge connects Sault Sainte Marie, Ont., *foreground,* and Sault Sainte Marie, Mich.



better transportation between lakes Superior and Huron. A federal grant enabled Michigan to complete a canal with a lock in 1855. The United States government took over the canal's administration in 1881, and abolished tolls.

The American canals are about $1\frac{3}{4}$ miles (2.8 kilometers) long. Davis lock, opened in 1914, and Sabin lock, opened in 1919, are in the North Canal. The South Canal includes MacArthur lock, opened in 1943, and the new Poe lock, opened in 1969. This new lock, 110 feet (34 meters) wide, is the widest of the American canals. It replaced a smaller Poe lock, which was torn down in 1962.

The Canadian Canal. Canada completed its canal in 1895. It cost $4,935,809. Until the Davis lock was built, the larger lake ships used the Canadian canal. The Canadian canal is $1\frac{3}{10}$ miles (2 kilometers) long and 150 feet (46 meters) wide.

The 2-mile (3-kilometer) International Bridge carries traffic across the Saint Marys River at Sault Ste. Marie. The bridge opened in 1962. WILLIS F. DUNBAR

SOOCHOW (pop. 1,300,000), or SU-CHOU, is an ancient Chinese city known for its canals and *pagodas* (temples). Soochow lies in a rich agricultural region in Kiangsu Province, between Nanking and Shanghai. For location, see CHINA (political map). Soochow's factories produce chemicals and light machinery. Skilled craftsmen in the city carve jade and weave silks. RICHARD H. SOLOMON

SOONER STATE. See OKLAHOMA.

SOONG CHING-LING (1890-), MADAME SUN YAT-SEN, is a prominent figure in the Chinese Communist government. She served as a vice-chairman in the government from 1949 to 1975. Soong Ching-ling served as head of a national woman's organization and of the Sino-Soviet Friendship Association after the Communist victory in China. She was awarded the 1951 Stalin peace prize.

Soong Ching-ling was the second wife of Sun Yat-sen, the founder of the Chinese Republic (see SUN YAT-SEN). She worked with him in Japan and later married him there. After his death in 1925, Soong Ching-ling rose to a high position in the Chinese government. When Chiang Kai-shek, the president of the Chinese Nationalist government, broke with the Chinese Communists in 1927, she left China and lived in Moscow (see CHIANG KAI-SHEK). She remained in exile until Communist leaders joined the Kuomintang, the Nationalist Party, in a common front against the Japanese forces that invaded China in 1937.

Soong Ching-ling, the daughter of Charles Jones Soong, was born in K'un-shan, Kiangsu. She attended high school in Shanghai and graduated from Wesleyan College in Macon, Ga. IMMANUEL C. Y. HSU

SOOT is a black substance found in smoke. Soot is made up of tiny particles of fuel, such as coal, wood, or oil, that have not been burned. These particles are usually considered harmful to man and plant life, but they also have a certain value. Soot contains a great deal of carbon and ammonium salts. The ammonium salts contain a large amount of nitrogen, which is an excellent fertilizer. Soot is therefore useful as a fertilizer.

Soot is used as a *pigment* (coloring matter). The soot found nearest the fire is usually a shining brown powder containing dried tar. This soot is used as a pigment which is called *bister*. The soot found farther from the fire and up higher in the chimney is usually black. It is used as a pigment which is called *lampblack*.

Soot sticks to anything it touches. For this reason, smoke blowing through a city leaves its soot upon buildings and makes them look dingy. In some cities, about 3 per cent of the coal that is burned is converted into soot. This soot formation is a serious waste and has added to the problem of smoke prevention. RALPH G. OWENS

See also FIRE (What Fire Produces).

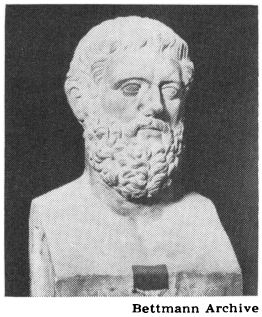
SOPHIST PHILOSOPHY was an educational movement in the city-states of Greece during the second half of the 400's B.C. The Sophists were migrant teachers who taught grammar and public speaking, which was vital in such ancient democracies as Athens. They were

not interested in philosophical thoughts about the nature of the physical universe. Instead, they criticized conventional morality and religion, and described virtue as being successful in the world.

The Sophists believed that law is not part of the nature of things, but is merely custom. Thus, they said, men who are clever enough to evade laws have no moral obligation to obey them. Plato described Socrates as opposing the Sophists because their ideas were vague and contradictory, and especially because their teachings could destroy the social order.

The best-known Sophists included Protagoras, Gorgias, and Antiphon. Protagoras believed that old customs and ceremonies should be followed so society could be held together. Gorgias became known for his intellectually stimulating and skeptical ideas. Antiphon emphasized the difference between civil law and man's natural search for pleasure in life. He believed man could often serve his own advantage by evading the law and following his natural desires, if he could get away with it. JOSIAH B. GOULD

SOPHOCLES, *SAHF uh klees* (496?-406? B.C.), was the second in time of the three great Greek writers of tragedy. The others were Aeschylus and Euripides. His tragedies were not concerned with abstract problems of guilt and punishment over several generations, like those of Aeschylus. Instead they dealt with a specific struggle of a strong individual against fate. Where Aeschylus required whole *trilogies* (three plays) to cover one subject, Sophocles wrote single plays.



Bettmann Archive

Sophocles

Sophocles' usual pattern is to show a powerful figure who chooses a course which the chorus and lesser characters may not approve. This course costs him suffering or death, but it makes him more noble and somehow benefits mankind. Sophocles did not make his figures ordinary in order to criticize conventional morality, as Euripides did. That is why Aristotle said that Sophocles pictured men as they should be, Euripides as they are.

Artistically and in their dramatic construction, Sophocles' plays are more finished than those of Aeschylus or Euripides, and Aristotle regarded his works as models. Sophocles added a third actor, fixed the size of the chorus at 15, and used scene-painting. His plays show intrigue and suspense. Of the 100 or more plays Sophocles wrote, seven complete ones have survived. These are *Ajax*, *Antigone*, *Trachinian Women*, *Oedipus Rex*, *Electra*, *Philoctetes*, and *Oedipus at Colonus*. Part of one of Sophocles' plays, called *The Trackers*, was found in 1907.

Sophocles was a fortunate man. He lived during Athens' greatest period. He won many prizes for his tragedies, and was universally loved. One of his greatest plays, *Oedipus at Colonus*, was written when he was nearly 90. He was born near Athens, and remained there all his life. MOSES HADAS

See also ANTIGONE; GREEK LITERATURE; OEDIPUS.

SOPRANO, *suh PRAN oh* or *suh PRAH noh*, is a term describing a type of voice. It may also mean a voice part in compositions for mixed voices. The soprano voice is the highest of four voices. It usually covers more than two octaves above middle C. A woman or a young boy may sing it. A soprano part is the upper voice part in a harmonic arrangement to be sung by mixed voices. See also OPERA. RAYMOND KENDALL

SORATA is another name for Illampu, a peak of the Andes Mountains in Bolivia. See ILLAMPU.

SORBONNE, *sawr BAHN*, is the name of a famous institution of learning in Paris, the outgrowth of a medieval college of theology. It is a part of the state-owned University of Paris. One of the finest university buildings in the world houses the present-day Sorbonne. It dates from 1889, and is known as *La Nouvelle Sorbonne* (The New Sorbonne). The institution maintains faculties of science, law, literature, and medicine. The Sorbonne has well-equipped laboratories, lecture rooms, and libraries.

Robert of Sorbon founded the old Sorbonne in the 1200's. Originally it was a residence hall for poor theological students. It gradually became one of the strongest theological schools in Europe. In the 1600's, Cardinal Richelieu rebuilt it and provided a magnificent chapel for the students. In 1885, the faculty of theology was abolished.

Students from many parts of the world study at the Sorbonne. As many as 35,000 foreign students have enrolled there in one year. I. L. KANDEL

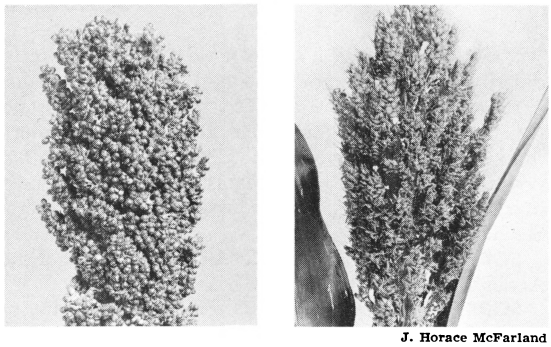
SORCERER. See MAGIC (The Magician); WITCHCRAFT.

SOREL, *saw REL*, Quebec (pop. 19,347), is an industrial and shipping center at the junction of the Richelieu and St. Lawrence rivers. A good port with a deepwater front, it is on the Canadian National Railways. Sorel's industries include shipbuilding and ship-repair plants, steel foundries, lumber mills, and clothing and shirt factories. Sorel has a mayor-council form of government. MURRAY G. BALLANTYNE

SORENSEN, VIRGINIA (1912-), is an American author. She won the 1957 Newbery medal for her children's book *Miracles on Maple Hill*, the story of a 10-year-old girl in the farmland of Pennsylvania. Her story *Plain Girl*, about the life of a small Amish girl, won the Children's Book Award of the Child Study Association of America in 1955. Mrs. Sorensen also wrote *Curious Missie* (1953), *The House Next Door* (1954), *Lotte's Locket* (1964), a number of adult novels, and a collection of short stories. She was born in Provo, Utah. ELOISE RUE

SORET, J. LOUIS. See HOLMIUM.

SORGHUM, *SAWR guhm*, is the name of a group of tropical grasses from Africa and Asia. In regions of warm summer climate, farmers grow some of them for forage, syrup, grain, and broom fiber. The common varieties of sorghum have thick, solid stalks and look like corn plants. But their flowers grow in branched clusters at the tips of the stems. Farmers plant and grow sorghums in much the same manner as they do corn. About 20 million acres (8 million hectares) of sorghum are planted in the United States each year, especially in the Great Plains region. All sorghums fall into four main groups: (1) grain sorghums, (2) sweet sorghums, (3) grassy sorghums, and (4) broomcorn.



J. Horace McFarland

Sorghums furnish sap to make syrup and feed for livestock. Two kinds are Red Top African, *left*, and Milo Maize, *right*.

Grain Sorghums are grown especially for their rounded, starchy seeds. The grain serves as a substitute for corn in feeding animals. Some grain sorghums grow as much as 15 feet (5 meters) tall. Plant breeders have produced varieties 2 to 4 feet (0.6 to 1.2 meters) tall that can be harvested with a grain combine. Farmers feed the grain to livestock, or make the entire plant into silage. In India, Africa, and China, the grain is ground and made into pancakes or mush as food for man. Common grain sorghums include durra, milo, and kafir.

Sweet Sorghums, or *sorgos*, have sweet, juicy stems. They are grown especially for the production of sorghum syrup. This syrup is made by pressing the juice out of the stems with rollers and boiling it down to the proper thickness. Animal feed and silage can also be made from sweet sorghums.

Grassy Sorghums are used for green feed and hay. *Sudan grass* is a tall annual sorghum with thin stalks. It grows quickly and may reach 10 feet (3 meters) in height. It serves as excellent summer pasturage. Johnson grass, a perennial sorghum, grows as a weed in the southern United States. It resembles Sudan grass, but it spreads by creeping rootstocks. Johnson grass is a pest on land needed for cotton or other row crops. But it makes excellent cattle feed or hay.

Broomcorn is a kind of sorghum grown for the *brush* (branches) of the seed cluster.

Scientific Classification. The sorghums belong to the grass family, *Gramineae*. Grain sorghums, sweet sorghums, broomcorn, and Sudan grass are classified as genus *Sorghum*, species *S. vulgare*. Johnson grass is classified as *S. halepense*. WAYNE W. HUFFINE

See also KAFIR; SUDAN GRASS.

SOROKIN, PITIRIM A. See SOCIOLOGY (Modern Sociology).

SOROPTIMIST INTERNATIONAL ASSOCIATION is an organization of service clubs for professional and executive businesswomen. Soroptimist clubs have been organized in 30 countries and have a world membership of about 45,000 women. Each member of a Soroptimist club must represent a different profession or business. The purposes of the clubs include the advancement of world peace and of the status of women. Soroptimist clubs are divided into three federations: Soroptimist Federation of the Americas, Inc.; European Federation of Soroptimist Clubs; and Federation of Soroptimist Clubs of Great Britain and Ireland. The Americas federation has headquarters at 1616 Walnut St., Philadelphia, Pa. 19103. The first Soroptimist club was founded in Oakland, Calif., in 1921. MARTHA R. SERVIS

SORORITY, *suh ROAR uh tee*, is a women's society of college or university students and graduates. Sororities, like fraternities, are often called *Greek-letter societies*. Most sororities form their names by combining two or three letters of the Greek alphabet. The word *sorority* comes from the Latin word *soror*, which means *sister*.

There are three kinds of sororities: (1) *general*, or *social*, (2) *professional*, and (3) *honor societies*. General sororities, the most common of the three, encourage high academic standards, carry on charitable and educational programs, and sponsor social activities for their members. On many campuses, they also provide room and board for members in sorority houses. Professional sororities consist of women with the same academic interest, such as education or journalism. Honor societies are for women with exceptional academic records.

There are 35 national general sororities in the United States. They have a total of more than 2,800 collegiate *chapters* (local units) and about 5,300 alumnae chapters. Membership totals more than 1,400,000. Twenty-seven of the national sororities belong to the National Panhellenic Conference. It and similar organizations promote cooperation among national sororities. Most university and college campuses have an intersorority council, which regulates general sorority activity.

There are 35 U.S. professional sororities and honor societies. They have more than 3,300 chapters and about 540,000 members. Some groups admit men.

Many school clubs, the forerunners of sororities, were formed during the 1800's. *Adelphean* began as a literary society at Wesleyan College, in Macon, Ga., in 1851. It adopted the name *Alpha Delta Pi* in 1905. *Pi Beta Phi* was organized as I.C. Sorosis at Monmouth College in Monmouth, Ill., in 1867. It was the first organization of college women to be established on a national basis.

Kappa Alpha Theta was the first group founded as a women's Greek-letter society. It began at DePauw University in 1870. *Gamma Phi Beta*, founded at Syracuse University in 1874, was the first group to use the name *sorority*.

Critically reviewed by NATIONAL PANHELLENIC CONFERENCE

SORREL, *SAHR ul*, is a name given to several plants of the buckwheat family. All the sorrels have juicy leaves and stems that contain oxalic acid. This gives them a sour taste.

The common American sorrel is a low-growing plant with three-lobed, arrow-shaped leaves, and spikes of small white, pink, or yellow flowers. *Sheep sorrel*, *sour sorrel*, and *red sorrel* are some of the names for this plant. The name "red sorrel" comes from the masses of triangular reddish seeds the plant bears.

The common American sorrel is a weed that grows well in acid soil, and its presence in a meadow indicates that the land needs lime.

Scientific Classification. The common American sorrel belongs to the buckwheat family, *Polygonaceae*. It is genus *Rumex*, species *R. acetosella*. HAROLD NORMAN MOLDENKE

SORREL TREE, or SOURWOOD, is a beautiful tree of the heath family. It grows in the woods of the southern United States, and as far north as Pennsylvania, Indiana, and Ohio. The name *sourwood* comes from the

SORORITIES IN THE UNITED STATES

GENERAL SORORITIES

Name	College Chapters	Alumnae Chapters	Year Founded	Where Founded	National Headquarters
Alpha Chi Omega	112	272	1885	DePauw University	Indianapolis
Alpha Delta Pi	127	401	1851	Wesleyan College	Atlanta
Alpha Epsilon Phi	33	21	1909	Barnard College	Pittsburgh
Alpha Gamma Delta	108	225	1904	Syracuse University	Indianapolis
Alpha Kappa Alpha	179	243	1908	Howard University	Chicago
Alpha Omicron Pi	95	180	1897	Barnard College	Indianapolis
Alpha Phi	96	210	1872	Syracuse University	Evanston, Ill.
Alpha Sigma Alpha	51	104	1901	Longwood College	Springfield, Mo.
Alpha Sigma Tau	34	45	1899	Eastern Michigan University	St. Louis
Alpha Xi Delta	115	174	1893	Knox College	Indianapolis
Chi Omega	152	189	1895	University of Arkansas	Cincinnati
Delta Delta Delta	119	332	1888	Boston University	Arlington, Tex.
Delta Gamma	100	255	1873	Oxford, Miss.	Columbus, O.
Delta Phi Epsilon	28	38	1917	New York University	Norwalk, Conn.
Delta Sigma Theta	230	285	1913	Howard University	Washington, D.C.
Delta Zeta	176	302	1902	Miami University	Columbus, O.
Eta Upsilon Gamma	5	7	1901	Christian College (Mo.)	None
Gamma Phi Beta	91	203	1874	Syracuse University	Kenilworth, Ill.
Kappa Alpha Theta	94	304	1870	DePauw University	Evanston, Ill.
Kappa Delta	115	386	1897	Longwood College	Springfield, Mo.
Kappa Kappa Gamma	92	352	1870	Monmouth College (Ill.)	Columbus, O.
Phi Mu	122	189	1852	Wesleyan College	Memphis, Tenn.
Phi Sigma Sigma	24	43	1913	Hunter College	Coral Gables, Fla.
Pi Beta Phi	109	320	1867	Monmouth College (Ill.)	St. Louis
Sigma Delta Tau	29	24	1917	Cornell University	Kenilworth, Ill.
Sigma Gamma Rho	125	100	1922	Butler University	Chicago
Sigma Iota Chi	5	2	1903	Alexandria, La.	Encinitas, Calif.
Sigma Kappa	100	260	1874	Colby College	Indianapolis
Sigma Sigma Sigma	73	150	1898	Longwood College	Woodstock, Va.
Theta Phi Alpha	19	26	1912	University of Michigan	Cincinnati
Zeta Phi Beta	90	200	1920	Howard University	Washington, D.C.
Zeta Tau Alpha	130	385	1898	Longwood College	Evanston, Ill.

LARGEST PROFESSIONAL SORORITIES AND HONOR SOCIETIES*

Name	College Chapters	Alumnae Chapters	Year Founded	Where Founded	National Headquarters
Delta Kappa Gamma (Education)†	None	2,383	1929	Austin, Tex.	Austin, Tex.
Alpha Lambda Delta (Freshmen)†	175	None	1924	University of Illinois	Lewisburg, Pa.
Pi Lambda Theta (Education)†**	66	37	1910	University of Missouri	Bloomington, Ind.
Mortar Board (Leadership)†	161	50	1918	Syracuse, N.Y.	Columbus, O.
Alpha Iota (Business & Commerce)†	85	76	1925	Des Moines, Ia.	Des Moines, Ia.
Sigma Alpha Iota (Music)**	174	116	1903	University of Michigan	Des Moines, Ia.
Alpha Delta Kappa (Education)**	None	1,500	1947	Kansas City, Mo.	Kansas City, Mo.
Omicron Nu (Home Economics)†**	45	4	1912	Michigan State University	East Lansing, Mich.
Mu Phi Epsilon (Music)**	125	88	1903	Cincinnati	Campbell, Calif.
Phi Upsilon Omicron (Home Economics)†**	67	25	1909	University of Minnesota	Fargo, N. Dak.
Kappa Delta Epsilon (Education)**	37	5	1933	Washington, D.C.	Decatur, Ga.

*Ranked by total membership since sorority was founded.
†Honor Society. **Professional Society.

Sources: WORLD BOOK questionnaires sent to sororities; *Encyclopedia of Associations*, © 1975 by Gale Research Co.

taste of its leaves and twigs, which hunters and woodsmen sometimes chew when they are thirsty. The name *sorrel* comes from an Old French word which means *sour*.

The sorrel tree may reach a height of 50 to 60 feet (15 to 18 meters). It has reddish-gray bark and smooth, oblong leaves. In summer it bears graceful clusters of small, bell-shaped, white flowers, which are soon followed by little downy capsules. In spring the foliage is bronze-green, but in autumn it turns a brilliant scarlet. The wood is sometimes used to make handles for tools. Leaves of the sorrel tree furnish a black dye.

Scientific Classification. The sorrel tree belongs to the heath family, *Ericaceae*. It is classified as genus *Oxydendrum*, species *O. arboreum*. THEODORE W. BRETZ

S O S is the accepted call for help from a ship in distress. It does not stand for anything. It was chosen because it was convenient to send by wireless. It consists of three dots, three dashes, and three dots.

SOTO, HERNANDO DE. See DE SOTO, HERNANDO.

SOU was a small coin in the French money system. It was worth 5 *centimes* (hundredths of a franc). It has not been used since World War II.

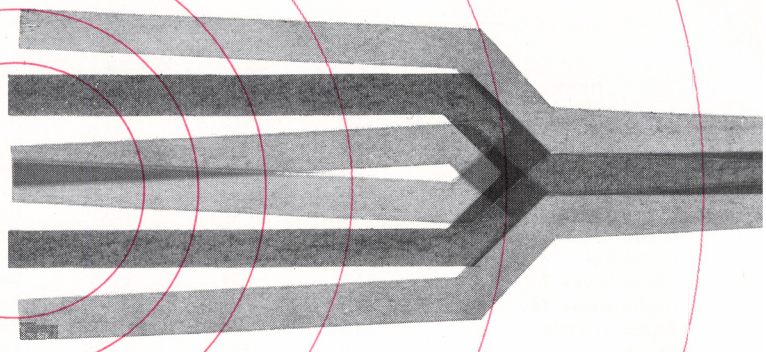
SOUL. See RELIGION (Life and Death); MIND (The Nature of Mind); TRANSMIGRATION OF THE SOUL.

SOULE, JOHN, originated the phrase, "Go West, young man." See GREELEY, HORACE.

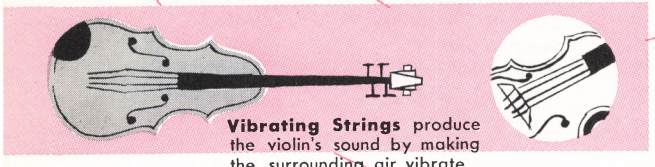
SOULÉ, PIERRE. See OSTEND MANIFESTO.

SOULÉ, SAMUEL W. See TYPEWRITER (History; pictures).

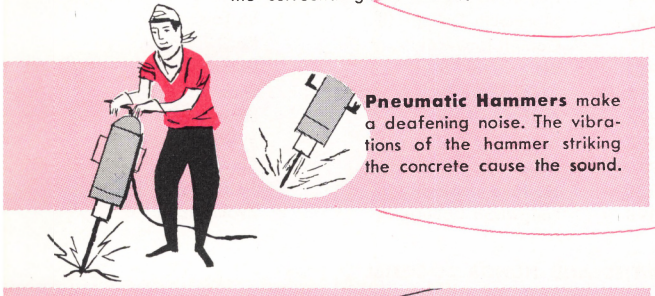
SOUND



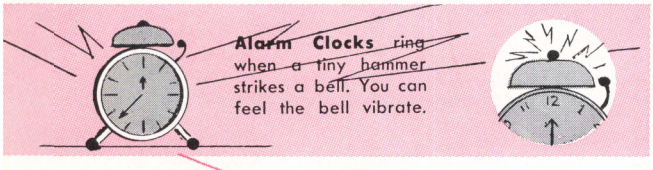
VIBRATIONS PRODUCE SOUND



Vibrating Strings produce the violin's sound by making the surrounding air vibrate.



Pneumatic Hammers make a deafening noise. The vibrations of the hammer striking the concrete cause the sound.



Alarm Clocks ring when a tiny hammer strikes a bell. You can feel the bell vibrate.

The Screech of chalk is caused when it vibrates on a chalkboard.

SOUND is all around us. The whispering wind may lull you to sleep at night. A jingling alarm clock may awaken you in the morning. The voices of friends, the roar of machinery, the rustle of papers, the clatter of pans, and countless other sounds surround us.

All these sounds have one thing in common. Each is caused when something moves back and forth in quivering motions called *vibrations*. These vibrations travel through the air to our ears, and we hear them as sounds. If you gently put your fingers on a ringing bell, you can feel it vibrating. If you press harder, you will stop both the vibrations and the sound.

The air can carry many vibrations at the same time, and the vibrations can travel in many different directions. You may sit in a room and hear a radio playing, a bird singing, a friend talking, and an airplane passing overhead, all at the same time.

A world without sound would be unpleasant and even dangerous. It is the world of a deaf person. We would be unable to chat with our families and friends, either in the same room or by telephone. We would not be protected by such warning devices as automobile horns.

What Is Sound?

A famous riddle asks whether sound is produced when a tree crashes to earth in a distant forest and no one hears it. This question is a riddle because there are two ways to define sound. One way is to define it as something that is heard. According to this definition, the tree makes no sound because no one hears it. The second way is to define sound as vibrations produced by an object. According to this definition, the tree makes sound because it produces vibrations when it crashes.

Most scientists use the second definition. This definition describes events that occur in nature rather than the act of hearing these events.

Producing Sound. When an object vibrates, it makes the surrounding air vibrate. This vibration of the air has two causes. First, as the vibrating object moves outward, it *compresses* the surrounding air. Second, the air *expands*, or rushes into the space formerly occupied by the vibrating object, when the object moves inward. Each succeeding vibration of the object again causes the surrounding air to compress and expand.

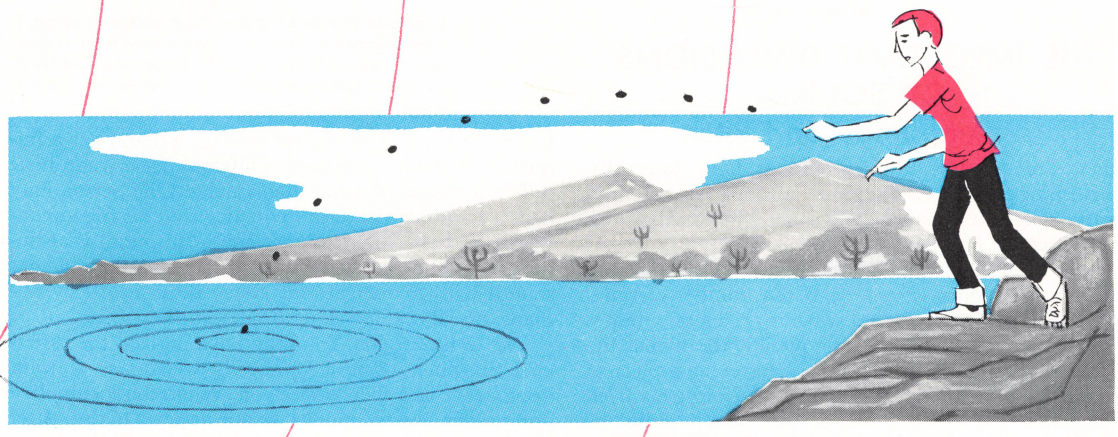
Scientists call these compressions and expansions *condensations* and *rarefactions*. The compressions and expansions of the air near the source of the sound also compress and expand the air farther away. In this way, a vibration travels through the air until it weakens and dies away. These vibrations are known as *sound waves*.

You can demonstrate sound vibrations with a tuning fork. Strike the fork and dip the prongs of the fork into a glass of water. The vibrations of the prongs will make the water splatter. See TUNING FORK; VIBRATION.

Sound Waves travel along the back-and-forth movement of the vibrating object that produces them. Scientists call these waves *longitudinal waves* or *compressional waves*. You can see longitudinal waves by attaching one end of a long spiral spring to a hook or some other

SOUND TRAVELS IN WAVES

If you throw a rock in a pool of water, you will see small ripples, or waves, travel outward from the point where the rock struck the surface. Sound also travels in waves. When an object vibrates and produces sound, it makes the surrounding air vibrate. These vibrations ripple outward in waves in all directions from the object. When the waves reach our ears, we hear them as sounds.



support. Allow the other end of the spring to hang free. Pull apart and then release several turns of the spring near its free end. You will see a stretching motion travel up to the attached end of the spring and return to the free end. If you pinch together and then release part of the spring at its free end, a wave of compression will travel up to the other end and return. Sound waves travel through the air in a similar way. They consist of compressed and expanded air that moves back and forth in the direction the wave is traveling. See WAVES.

How Sound Travels. You may have read how Indians once put their ears to the ground to detect the approach of an enemy. This shows that sound travels through a *medium*, or substance, such as the ground or the air.

The *speed of sound* depends upon two factors: (1) the density of the medium through which sound waves travel, and (2) the elasticity of the medium (see DENSITY; ELASTICITY). The more elastic a medium, the greater the speed of sound. The denser a medium, the slower the speed of sound. Steel is 6,000 times denser than air. But it is also two million times more elastic. Therefore, sound travels more swiftly through steel than through air. Sound travels about 16,400 feet (5,000 meters) per second in steel, but only about 1,087 feet (331 meters) per second in air at 32° F. (0° C).

The density and elasticity of air change as the temperature changes. For this reason the speed of sound in air changes with the temperature. It increases by about 1 foot a second for each increase of 1 degree Fahrenheit, or about 0.5 meter for each degree Celsius.

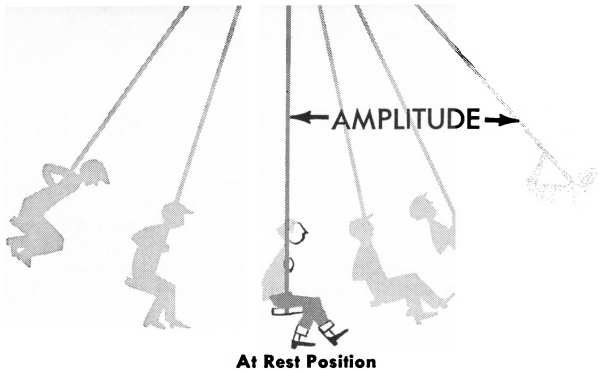
The speed of sound is much slower than the speed of light, which is 186,282 miles (299,792 kilometers) per second. You almost always see the flash of lightning before you hear the sound of thunder. When a gun is fired, you usually see the puff of smoke from the gun barrel before you hear the sound of the shot. If you know the time in seconds between a flash of lightning and the sound of thunder, you can tell how far away the lightning is. At the normal temperature range in the United States and Canada, the lightning will be about 1 mile away for every 5 seconds between flash and thunder, or about 1 kilometer for every 3 seconds. Jet airplanes often fly at *supersonic speeds* (faster than the speed of sound). The ratio of the speed of an airplane to the speed of sound in the air through which it is flying is called the *Mach number*. See AERODYNAMICS (Shock Waves and Sonic Booms).

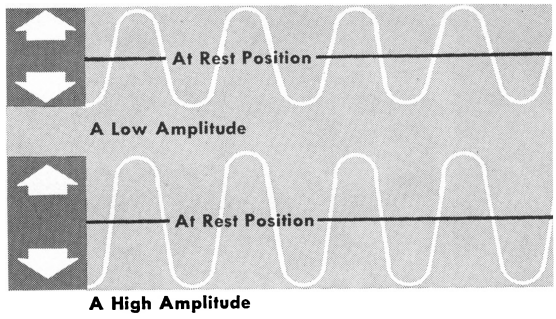
Hearing Sound. The construction of the ear enables it to catch sound waves that come to it through the air. The waves enter your ears and travel along tubes to the eardrums and other delicate organs in the head. These organs send nerve impulses over sensitive nerves to the brain, which interprets what we hear. See EAR.

Some sounds do not vibrate with enough energy to make the eardrums vibrate. These sounds are not loud enough to be heard. They are said to be below the *threshold of audibility*, the point at which we can hear sounds. Some sounds have so much energy that they hurt the ear. These sounds are above the *threshold of feeling*. Sounds made by violent explosions, such as the firing of a large cannon, often reach the threshold of feeling. A sound at the threshold of feeling has about five billion times as much energy as the sound of a whispering voice. Sounds must be made more and more intense to reach the threshold of audibility of a person who is becoming deaf. When the sounds must be so intense that the threshold of feeling is reached, the person is deaf. See DEAFNESS.

Characteristics of Sound

Sound waves must have different characteristics, because we can distinguish one kind of sound from an-





Amplitude can be compared to a boy on a swing. It is the distance a vibrating object moves from its position of rest as it vibrates. The larger the amplitude of sound vibrations, the more intense the sound.

THE IMPORTANT DIMENSIONS OF SOUND ...Amplitude and Pitch

other. For example, musical sounds have three distinguishing characteristics: pitch, loudness, and quality. Beats, echoes, resonance, and sympathetic vibrations also affect the character of sound.

Pitch is determined by how rapidly an object vibrates, or by its frequency. *Frequency* is the number of times that an object, or the sound wave it produces, vibrates in a second. The higher the frequency, the higher the pitch. You can demonstrate this by fastening a piece of cardboard so it touches the spokes of a bicycle wheel. The faster you turn the wheel, the more rapidly the cardboard vibrates, and the higher the pitch of the sound you hear. You also may have noticed how the pitch of the sounds made by an electric fan or by a phonograph record rises and falls as their speed of rotation is increased or decreased. See PITCH.

Audible Range of Frequencies. The normal human ear can hear sounds with frequencies between about 20 and 20,000 vibrations a second. Scientists refer to each vibration a second as one *hertz*. For example, the lowest tone on a piano has a frequency of 27 vibrations a second, or 27 hertz. Some organs have tones with frequencies as low as 15 hertz. The highest tone on a piano has a frequency of about 4,000 hertz. Different persons can hear different ranges of sound frequencies. One person may hear a sound of a certain frequency that his friend cannot hear at all. Some animals can hear sounds that humans cannot hear. Dogs and bats, for example, can hear sounds with frequencies far above those heard by humans. See BAT (How Bats Navigate); DOG (Ears).

The Doppler Effect. You may have noticed the difference in pitch of a locomotive's whistle as a train approaches and then passes you. When the locomotive approaches, the pitch of its whistle appears to rise. After the locomotive passes, the pitch of its whistle drops. More sound vibrations reach your ear each second as the locomotive approaches, because the sound waves are crowded together. You hear fewer vibrations afterward because the sound waves are stretched apart. Actually, the whistle has only one pitch. The apparent change in the pitch of sounds made by moving objects is called the *Doppler effect* (see DOPPLER EFFECT).

Loudness and Intensity. People often use the words *loudness* and *intensity* as if they mean the same thing. But the words have different meanings.

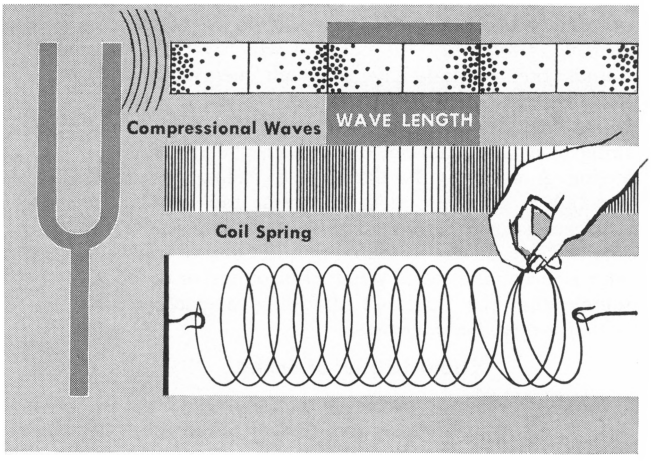
The *intensity* of sound refers to the amount of energy flowing in the sound waves (see ENERGY). The *loudness* of sound is the apparent strength of the sensation received by the eardrum and sent to the brain. The same intensity of sound may produce different degrees of loudness for different people. For example, one person may barely hear a sound that seems clear to another. But for any one person, both the intensity and loudness of a sound depend on four factors: (1) the distance from the source of the sound, (2) the amplitude of vibration, (3) the density of the medium through which the sound travels, and (4) the area of the vibrating object.

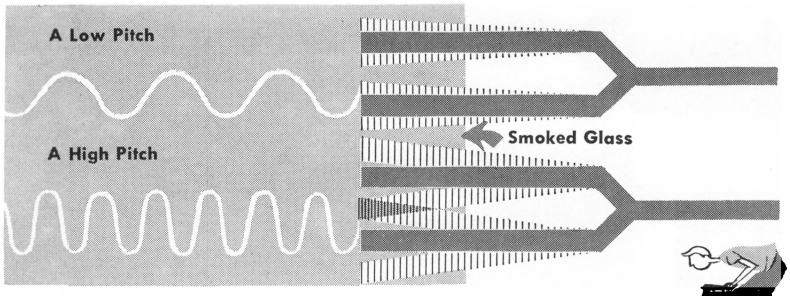
The intensity and loudness of a sound decrease as the *distance* increases between a person and the source of the sound. This happens because sound waves move out from their source in all directions. The energy flowing in the sound waves spreads over a greater area and decreases the farther away the sound travels. That is why cheerleaders use megaphones when shouting to a crowd at a football game. The megaphone prevents the sudden spreading of the sound waves, and directs more of the sound energy toward the crowd.

The *amplitude of vibration* is the distance that a vibrating object moves as it vibrates. For example, the amplitude of vibration of a boy on a swing is the distance he moves front and back as he swings. It takes

WHAT SOUND WAVES LOOK LIKE

Sound waves consist of alternate condensed and expanded particles of air, and are called *compressional waves*. The length of such waves is measured from condensation to condensation. Attach one end of a coil spring to a wall and pinch several coils in the free end. A wave of compression will flow up and down the spring.

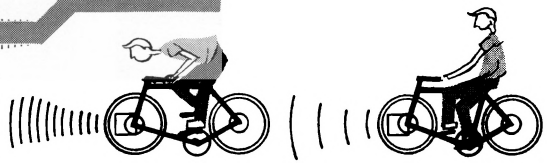




Pitch depends on *frequency*, or how rapidly an object vibrates. The more rapidly an object vibrates, the higher the pitch. You can see pitch and amplitude if you hold a sounding tuning fork against smoked glass.

PITCH

You can demonstrate pitch with a piece of cardboard fastened so it touches the spokes of a bicycle wheel. The faster you pedal, the faster the cardboard vibrates, and the higher the pitch of the sound.



more energy for a swing to have a large amplitude of vibration than a small amplitude. For the same reason, it requires more energy for an object such as a tuning fork or a violin string to have a large amplitude of vibration than a small amplitude. The larger the amplitude of vibration of a sounding body, the louder and more intense the sound. The amplitudes of sound waves are measured from condensation to condensation.

The loudness and intensity of a sound decrease as the *density* of the medium decreases. For example, compare the loudness of a sound made by striking two stones together under water with the loudness produced when you strike them together in air. The sound is much louder under water, because water is denser than air.

The *area*, or size, of a vibrating object also affects the loudness and intensity of a sound. You can prove this by hitting a table fork so that its prongs vibrate. Then quickly put the handle of the fork against the top of a table. The loudness of the sound made by the vibrating fork immediately increases, because the fork makes the table top vibrate. This increases the area of vibration. Notice how much louder a ticking clock sounds if you place it so the frame of the clock rests against a table top.

Pitch affects the loudness, but not the intensity, of a sound. The sensitivity of the ear varies with the pitch of a sound. The ear has low sensitivity to low pitches. But its sensitivity increases as the pitch increases, until the pitch reaches about 1,000 vibrations a second. After this point, its sensitivity to sound decreases again.

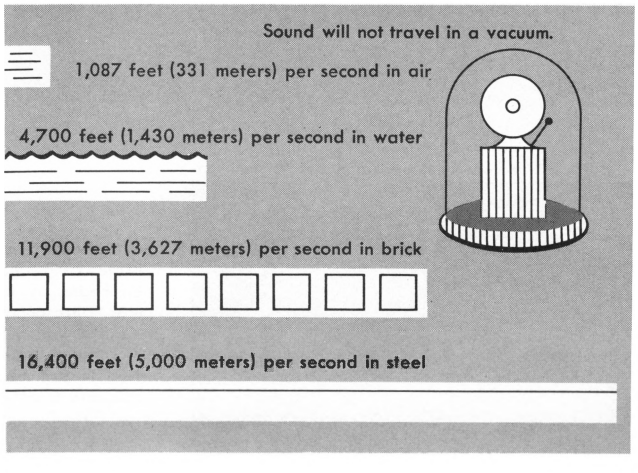
Quality of Sound is a characteristic of a musical tone. It distinguishes a tone produced by one musical instrument from a tone of the same pitch and intensity produced by another instrument. For example, quality makes the difference between the same tones from a violin and a banjo, even though both tones have the same pitch and intensity.

The quality of a musical tone generally results from the blending of many frequencies. A vibrating object produces many frequencies by vibrating both as a whole and in parts at the same time. For example, a violin string may vibrate as a whole 256 times a second. This produces the string's *fundamental tone*, and is middle C on the musical scale. At the same time, the string may also vibrate in several parts. That is, each half of the string, each third of the string, and each fourth of the string may vibrate separately. These vibrations of the parts of a string produce *overtones*. Overtones are also called *harmonics* of the fundamental frequency. The overtones produced by each half of the string vibrate at a frequency of 512 times a second, or twice the frequency of the fundamental tone. Therefore, these overtones are known as the *second harmonic*. The overtones produced by each third of the string (the *third harmonic*) vibrate at a frequency of 768 times a second, or three times the frequency of the fundamental tone. The overtones produced by each fourth of the string (the *fourth harmonic*) vibrate at a frequency four times that of the fundamental tone, and so on. The number and relative strength of the overtones determine the quality of a tone. See Harmonics; Tone.

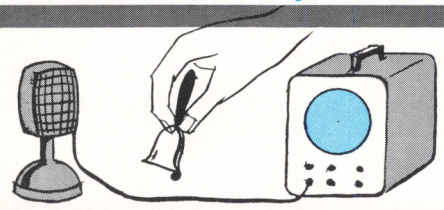
Beats. When two tuning forks that vibrate at the same frequency are sounded together, their tones blend and strengthen each other. But if the forks vibrate at different frequencies, the sounds they produce will swell and fade at regular intervals. The swellings, or *pulsations*, of loudness are called *beats*. They occur because the vibrations of the forks are "out of step" with each other. The number of beats a second equals the number of vibrations that differ from each other in a second. If one tuning fork has a frequency of 256 vibrations a second and another fork has a frequency of 257 vibra-

SOUND TRAVELS AT DIFFERENT SPEEDS

The speed of sound depends on the density and elasticity of the substance through which the sound travels. The denser the substance, the slower the speed. The more elastic the substance, the higher the speed. Dense substances are often many times more elastic than less dense ones, and sound travels faster through them. Sound will not travel if there is no substance, as in a vacuum.



INTERESTING FACTS ABOUT SOUND

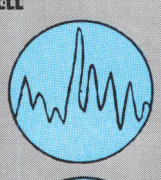


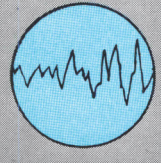
SEEING SOUND

Scientists and engineers often must know the pattern, or shape, of sound waves. They find this with an electronic device called an *oscilloscope, right above.* A microphone feeds the sound into the oscilloscope. The oscilloscope shows the sound waves on a fluorescent screen similar to a television screen.

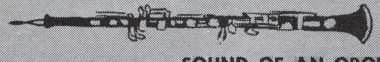
CLANG OF A BELL

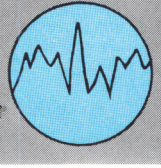
A AS IN FATHER



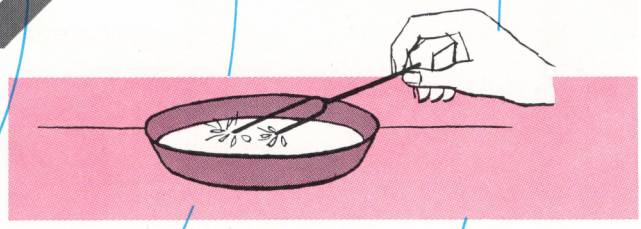


WHOOSH OF A SKYROCKET



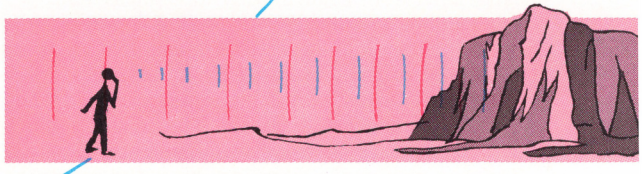


SOUND OF AN OBOE

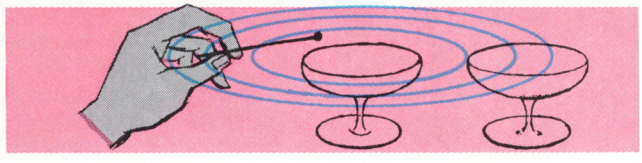


An Object Vibrates When It Produces Sound. You can show this by striking a tuning fork so it makes a sound. Then dip the fork into water. The vibrating prongs will splatter the water.

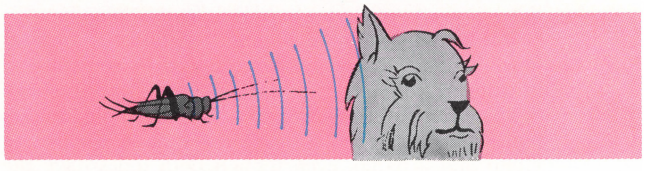
A Megaphone makes a shout sound louder, because it keeps the sound waves from spreading and sends them in one direction. For the same reason, cupping a hand to the ear helps to hear sound.



Echoes Can Measure Distance. Shout at a cliff and count the seconds it takes to hear the echo. Multiply by 544 to find the distance in feet, or by 166 to find the distance in meters.

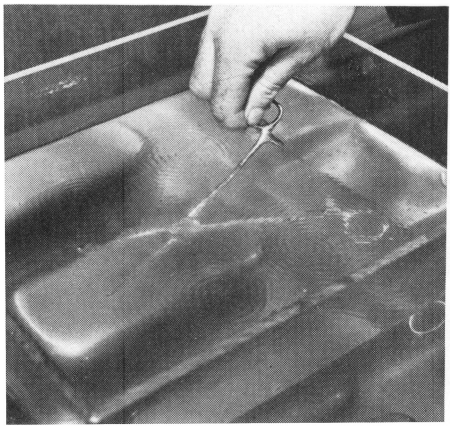


Sound Can Make Objects Vibrate. For example, the sound made when a glass is struck may make another glass vibrate. The vibrations of the second object are called *sympathetic vibrations.*

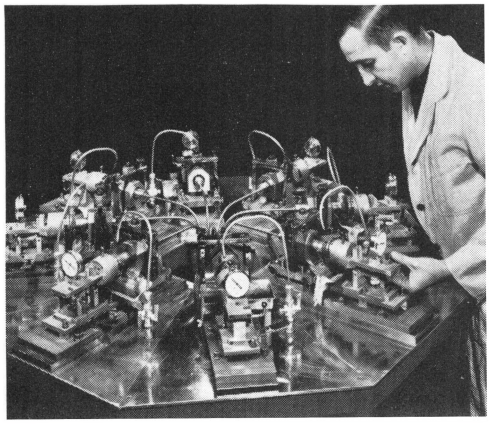


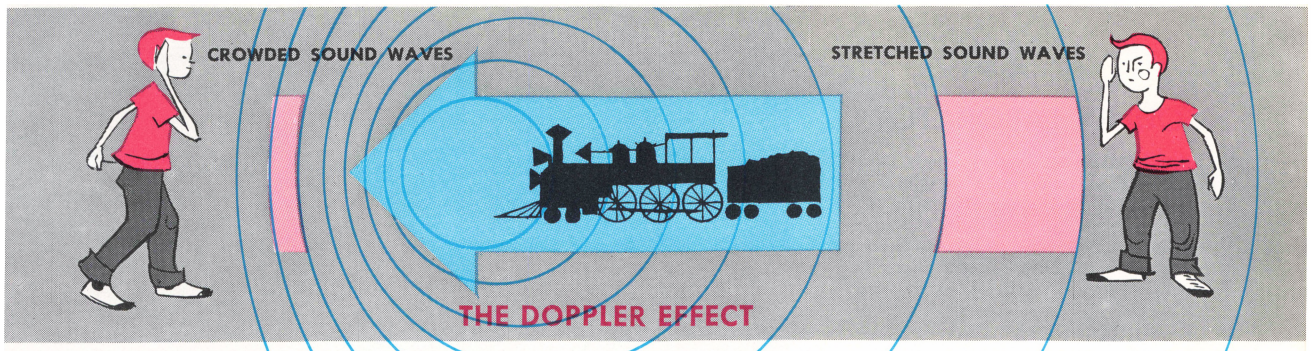
Animals Have Sensitive Hearing. Some animals, including bats, dogs, and various insects, can hear sounds with such high pitches that humans cannot hear them.

Acoustica Associates, Inc.; The Sheffield Corp.



Ultrasound, or sound that vibrates at frequencies too high to be heard by humans, has many uses. Ultrasound can be used to sterilize instruments, *left,* and to drill metal, *right.* It can also be used to drill teeth, to pasteurize milk, and to detect submarines.





The pitch of a train whistle seems to drop as the train passes by. This apparent change in pitch is called the *Doppler effect*. More sound waves strike your ear each second as the train approaches, because the sound waves are crowded together. You hear fewer sound waves each second after the train passes, because the waves are farther apart. Actually, the whistle has only one pitch.

tions a second, there will be one beat every second.

Most persons pay little attention if the number of beats produced by two vibrating objects is not more than five or six a second. But if the number of beats increases to 30 a second, the sound becomes unpleasant. Scientists call these sounds *dissonance*. As the number of beats increases above 30 a second, we no longer hear the separate beats, and the sensation of unpleasantness decreases. Musical instruments are tuned by changing their pitches to the same frequency to eliminate beats.

Echoes. We can produce echoes by shouting while standing some distance from a cliff or large building. In order to produce an echo, the sound waves we send out must strike some surface that has a density different from that of the surrounding air. The sound bounces back to us from this surface much as a rubber ball bounces back from a concrete wall. However, if we stand too close to the reflecting surface, we do not hear an echo. This is because a sound sensation lasts only about one tenth of a second. If a second sound is made within one tenth of a second, our ears cannot distinguish between the two sounds. An echo that returns before one tenth of a second has passed strengthens the original sound wave, but we hear no separate echo. See ECHO.

Resonance occurs when a small repeated force produces large vibrations in an object. For example, a series of small pushes can make a swing move in a bigger and bigger arc. But resonance occurs only if the force takes place at the same frequency as the natural frequency of the object. *Natural frequency* is the frequency at which the object would vibrate naturally if it were disturbed in some way. In the case of the swing, you must push with the same frequency at which the swing moves to keep it in motion. Resonance plays an important part in all musical instruments by increasing the loudness of the sounds they produce.

You can demonstrate resonance by holding a vibrating tuning fork over a tube that is open at one end and closed at the other end. If the tube is one fourth as long as the sound wave that comes from the fork, it will make the fork sound much louder. This increase in loudness is caused by resonance. A sound wave from the fork goes down the tube, hits the bottom, and bounces back to the fork just in time to cause it to vibrate with a larger amplitude. If the tube is not the proper length, the reflected sound wave will act against the vibration of the fork. This tends to make the fork stop vibrating, and is called *destructive interference*. See INTERFERENCE.

Sympathetic Vibrations are related to resonance. They can be demonstrated by hanging two rope swings of equal length from the same horizontal branch of a tree. If you set one swing in motion, the other swing will also start to move. Small impulses carried through the tree branch from the first swing to the second swing cause the motion of the second swing. These vibrations of the second swing are due to resonance and are called *sympathetic vibrations*. They would not occur if one swing were much longer than the other one—that is, if the natural frequencies of the two swings were greatly different from each other. The sound made when a certain note is hit on a piano may cause sympathetic vibrations among the dishes in a cupboard. Soldiers marching in step can cause sympathetic vibrations in a bridge and even make it fall. This is why troops break step while marching across bridges.

Kinds of Sound

Sounds can be classed as either noisy or musical. A *noise* is produced by a vibrating object, such as a rattling window, that sends out irregular vibrations at irregular intervals. *Music* is made by a vibrating body that sends out regular vibrations at regular intervals, such as a piano played by a skilled musician. Some other kinds of sound include the sounds made by people and animals, and stereophonic sound and ultrasound.

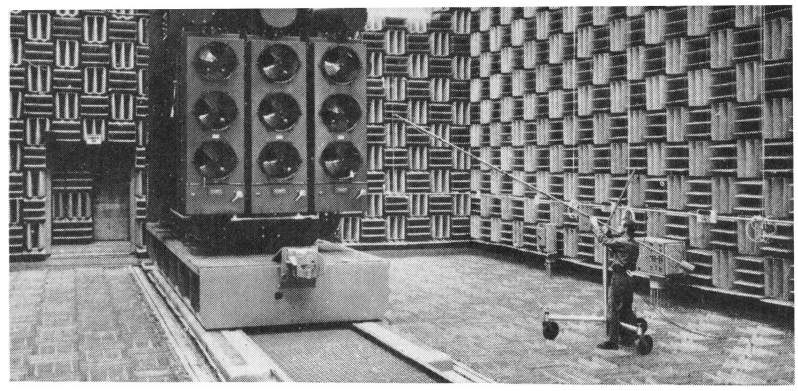
Noise can harm people in two ways. Intense noise may produce actual deafness. Boilermakers, steelworkers, and others who are exposed to intense noise for long periods sometimes become deaf. Jet airliners often make such loud, disturbing sounds that they are not allowed to use some airports. Continuous or periodic noise may cause people to become tired or irritable, even if it is not extremely loud. The steady whine of a saw or the periodic ringing of a telephone can cut a worker's production in half. Builders often cover the inside walls of offices and factories with felt, cork, and other materials that absorb sound. This reduces the noise and improves the efficiency of the workers. See INSULATION (Soundproofing).

Musical Sounds are made by three types of instruments: (1) stringed, (2) wind, and (3) percussion.

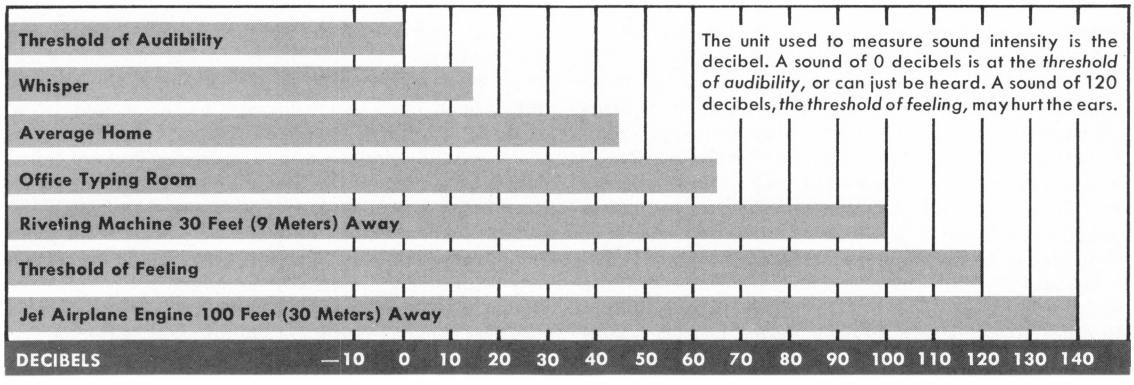
Stringed Instruments have strings stretched over some kind of *resonance box* or *board*. Violins and guitars, for example, have resonance boxes. Pianos have resonance boards. The *tension* (tightness) of a string controls the frequency at which it vibrates and, therefore, the pitch of the sound it makes. An increase in the tension of a string increases its frequency. However, the longer the string, the lower the frequency. The frequency of a string also decreases as its *mass per unit length* increases

SOUND LABORATORY

Scientists and engineers who study sound need special laboratories designed to eliminate unwanted sounds. The sound laboratory, *right*, is the world's largest *anechoic*, or echoless, chamber. Special materials that absorb sound line the floor, ceiling, and walls of the chamber.
General Electric Co.



THE MEASUREMENT OF SOUND



(see MASS). For example, a tight, heavy string has a lower pitch than an equally tight, light string. But a tight, heavy string has a higher pitch than a loose, heavy string.

A musician controls the length of the vibrating part of a string on a violin, or any similar instrument, by pressing his fingers on the string at different places. One end of the strings on these instruments is attached to the resonance box, and the other is wound about small pegs. The musician controls the tension of the strings by turning the pegs so that they loosen or tighten the strings. The mass per unit length is controlled by having strings with different masses. This provides a wide range of tones.

Wind Instruments. You may have produced a musical tone by blowing across the open top of a bottle. A musician plays a wind instrument in much the same way. He blows a stream of air across the opening of a tube or a pipe. The stream of air makes the air column inside the tube or pipe vibrate. The frequency of the vibration of this air column depends on the length of the tube or pipe. If the tube or pipe is closed at the bottom, the note produced has a wave length four times the length of the tube or pipe. If the tube or pipe is open at both ends, the note has a wave length twice the length of the tube or pipe.

All wind instruments work on this principle. A pipe organ, for example, has pipes of different lengths to produce different notes. Musicians press valves to regulate the length of the column of air that produces sounds in other wind instruments. Clarinets, saxophones, flutes, and horns have such valves to shorten or lengthen the air column. A musician controls the length of the air column in a slide trombone with a slide.

A reed helps make the air columns vibrate in wind instruments such as the saxophone, clarinet, oboe, and bassoon. In brass instruments, such as the trumpet and French horn, the vibrating lips of the musician make the air columns vibrate.

Percussion Instruments include drums, cymbals, bells, and gongs. A drum has a membrane stretched tightly across the open ends of a cylinder made of metal or wood. The musician beats the membrane with sticks or his hands. This makes the membrane vibrate and produce sound. Musicians also beat solid metal instruments such as cymbals, bells, and chimes to make them vibrate. These instruments, like the drum, create musical effects when used with other instruments, but often produce unpleasant sounds when used alone. See MUSIC.

The Human Voice is an example of sound produced by air columns vibrated by membranes. A pair of membranes called *vocal cords* are located on each side of the *larynx*, or *voice box*, in the throat. You make these cords vibrate and produce sounds by forcing air past them. Changing the muscular tension of the cords produces sounds of different pitches. See LARYNX.

Animal Sounds. Animals make and use sounds in many ways. For example, lions roar, birds sing, dogs bark, and cats meow. These and many other animals have vocal cords, and make their sounds the same way that humans do.

The cricket rubs the rough surfaces of its wings together to make its cheery chirp. The buzzing of flies, bees, and some other insects is caused by the vibration of their wings as they beat against the air.

One of the most interesting animal sounds is one that people cannot hear: the high-pitched twittering of bats. The pitch of these sounds is far above the frequency that humans can hear. But bats can hear them. The bat makes these sounds as it flies in the dark, and listens for

echoes. The echoes warn the bat when it approaches a tree, house, or some other obstacle. See BAT.

Stereophonic Sound. Perhaps you have heard the big difference between "live" music at a concert and the same music on an ordinary recording. In a concert hall, the music reaches you from many points. Your ears hear separate instruments or groups of instruments. At the same time, the sounds of the orchestra blend and fill the air. An ordinary recording lacks brilliance, because the music comes from only one point, often only a single loudspeaker.

Stereophonic sound tries to reproduce the feeling of depth, or of sounds coming from many points, that a listener would receive if he heard the sounds in person. To create this effect, engineers make two or more separate recordings from microphones placed at various points around an orchestra. In the home, these separate recordings, combined on one tape or disk, are played back, each through its own loudspeaker system. The loudspeakers are located at various places in the room, so that the music comes to the listener from different points. This gives the music a feeling of depth.

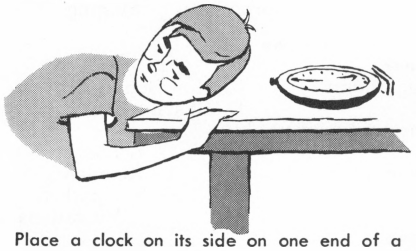
Ultrasound vibrates at frequencies too high to be heard by humans, more than 20,000 vibrations per second. Commonly used ultrasonic waves may have frequencies that range as high as 500 million vibrations per second. The M.I.T. Laboratory at Lexington, Mass., has produced sound waves that have a frequency of 70 billion vibrations per second.

Ultrasonic waves have many uses, because they can be focused much like the beam of light from a searchlight. An obstacle strongly reflects a beam of ultrasonic waves. An ultrasonic device detects objects by sending out a beam of ultrasonic waves and listening for echoes reflected from the objects. For example, naval vessels have ultrasonic devices called *sonar* to detect submarines under water (see SONAR). Scientists measure the depth of the ocean with similar devices, and fishermen use them to locate schools of fish. Factories use ultrasonic waves in much the same way to detect flaws in metals, wood, and other materials. Railroads regularly check their tracks with ultrasonic waves to locate weaknesses that might cause the tracks to break. Ultrasonic waves can also kill insects, pasteurize milk, sterilize surgical instruments, and treat diseases such as arthritis. Many dentists use ultrasonic drills that lessen the patient's discomfort.

Ultrasonic waves can be produced by sirens, and in several other ways (see SIREN). In one method, an alternating current of electricity is sent through a quartz crystal. The electrical variations of the current make the crystal expand and contract rapidly so that it produces ultrasonic vibrations in the surrounding medium. Certain ceramic materials such as barium titanate produce ultrasonic waves in the same way that quartz crystals do, and are more useful than quartz. Devices that use these materials are called *transducers*. An iron or nickel rod vibrated by an alternating magnetic field

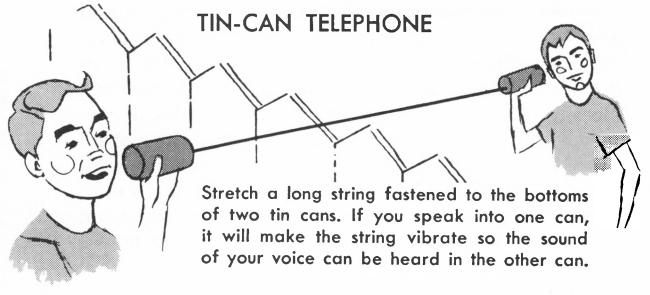
SIMPLE EXPERIMENTS WITH SOUND

HOW SOUND TRAVELS



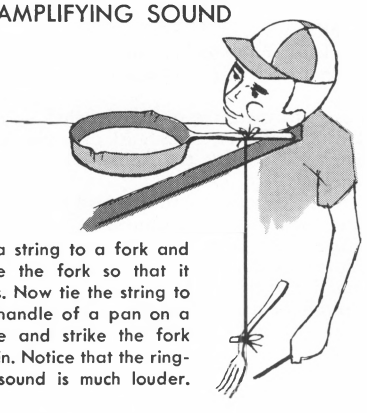
Place a clock on its side on one end of a table, and press your ear to the other end. You will hear the tick of the clock. This shows that sound travels through a substance.

TIN-CAN TELEPHONE



Stretch a long string fastened to the bottoms of two tin cans. If you speak into one can, it will make the string vibrate so the sound of your voice can be heard in the other can.

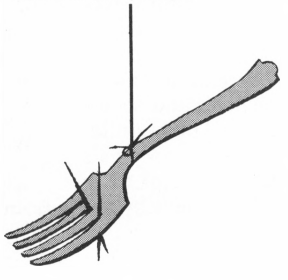
AMPLIFYING SOUND



Tie a string to a fork and strike the fork so that it rings. Now tie the string to the handle of a pan on a table and strike the fork again. Notice that the ringing sound is much louder.

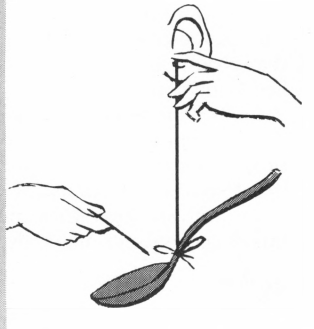
DEADENING SOUND

You can *mute*, or deaden, the sound of the fork, *left*, if you insert toothpicks or paper between the prongs.



SPOON BELL

Tie a string to a spoon and hold the string to your ear. Hit the spoon and hear it ring.



can also produce ultrasonic waves. This method is known as *magnetostriction*.

Working with Sound

Measuring Sound. The unit commonly used to measure the intensity of sound is the *decibel*. The decibel system is a *compressed scale* of measurement. Under this system, a sound intensity of 0 decibels is at the threshold of audibility for the normal human ear. A sound of 10 decibels transmits 10 times as much energy as a 0 decibel sound. A sound of 20 decibels transmits 100 times as much energy as a 0 decibel sound, a sound of 30 decibels transmits 1,000 times as much, and so on. A whisper amounts to only about 20 decibels. The ordinary speaking voice has an intensity of about 60 decibels. Automobile horns may reach an intensity of 90 decibels, and a jet airplane 100 feet (30 meters) away produces about 140 decibels. See DECIBEL.

The unit used to measure the loudness of sound is the *phon*. Sounds have different degrees of loudness at different frequencies. For example, a sound with an intensity of 60 decibels sounds louder at a frequency of 1,000 vibrations a second than at 500 vibrations a second. Therefore, to provide a loudness measure, the number of phons is said to be the same as the number of decibels for sounds produced at frequencies of 1,000 vibrations a second. Thus, a 60-decibel sound with a frequency of 1,000 vibrations a second has a loudness of 60 phons. A 60-decibel sound with a frequency of 500 vibrations a second has a smaller number of phons. A 60-decibel sound with a frequency of 2,000 vibrations a second also has less than 60 phons of loudness. This is because the sensitivity of the ear to loudness increases up to 1,000 vibrations a second. After this point, the sensitivity of the ear falls off again.

Sound Instruments enable scientists to study sound and put it to work in phonograph recordings, telephones, radio, television, and public address systems. The most important of these instruments include the microphone, the amplifier, the loudspeaker, and the oscilloscope.

A *microphone* changes sound waves into an electric current. A *loudspeaker* changes an electric current, such as the one produced by a microphone, back into sound. Usually, the currents from a microphone are too weak to make a loudspeaker work. Therefore, most sound systems have an *amplifier* that strengthens weak electric currents. Every radio, television set, phonograph, and public address system has at least one amplifier. See MICROPHONE; LOUDSPEAKER; ELECTRONICS.

In order to study sound, scientists and engineers must know the shape, or pattern, of sound waves. They can get such information from an *oscilloscope*, an electronic device similar to a television picture tube. For example, current from a microphone is fed into an oscilloscope. The oscilloscope shows the pattern of the sound waves that produced the current on a fluorescent glass screen. See OSCILLOSCOPE.

Controlling Sound. The science of *acoustics* deals with the problem of controlling sound. Scientists and acoustical engineers design theaters, schools, and other buildings to add clarity to useful sounds, such as a speaker's voice and an orchestra's music. The designs of these buildings, and the materials used, reduce noises by absorbing or reflecting unwanted sounds. See ACOUSTICS.

Recording Sound. Until the late 1800's, people had no way of preserving sound. Speeches, plays, and concerts were lost forever. About the 1870's, Thomas A. Edison and other scientists began developing ways of recording and reproducing sound. Edison invented the phonograph in 1877. Today we have three main ways of recording sound: (1) on disks or cylinders made of wax or plastics, (2) on film, and (3) on magnetic tape or wire. For articles describing these methods of recording sounds, see Sound Instruments and Devices in the *Related Articles* listed below.

ROBERT T. BEYER

Related Articles in WORLD BOOK include:

PRINCIPLES OF SOUND

Acoustics	Harmonics	Tone
Decibel	Interference	Ultrasound
Doppler Effect	Larynx	Vibration
Ear	Noise	Voice
Echo	Pitch	Waves

SOUND INSTRUMENTS AND DEVICES

Dictating Machine	Phonograph	Stethoscope
Electronics	Public Address System	Tape Recorder
Fathometer	Radio	Telephone (How the Telephone Works)
Hearing Aids	Siren	Television
High Fidelity	Sonar	Transducer
Loudspeaker	Sonometer	Tuning Fork
Microphone	Sound-Powered Telephone	Voder
Motion Picture		
Oscilloscope		

OTHER RELATED ARTICLES

Aerodynamics (Shock Waves and Sonic Booms)	Environmental Pollution (graph: Noise Pollution)	Mach, Ernst
Bell, Alexander G.	Frequency Modulation	Muffler
Berliner, Emile	Helmholtz, Hermann	Music (The Elements of Music)
Deafness	Insulation (Soundproofing)	Phonetics
Edison, Thomas A.		Singing

Outline

I. **What Is Sound?**
   - A. Producing Sound
   - B. Sound Waves
   - C. How Sound Travels
   - D. Hearing Sound

II. **Characteristics of Sound**
   - A. Pitch
   - B. Loudness and Intensity
   - C. Quality of Sound
   - D. Beats
   - E. Echoes
   - F. Resonance
   - G. Sympathetic Vibrations

III. **Kinds of Sound**
   - A. Noise
   - B. Musical Sounds
   - C. The Human Voice
   - D. Animal Sounds
   - E. Stereophonic Sound
   - F. Ultrasound

IV. **Working with Sound**
   - A. Measuring Sound
   - B. Sound Instruments
   - C. Controlling Sound
   - D. Recording Sound

Questions

What causes sound?

Does sound travel faster in steel or air? Why?

What do engineers mean when they say an airplane is supersonic?

How is sound used to measure ocean depths?

What is meant by a person's threshold of audibility?

What do scientists call sounds that vibrate more than 20,000 times a second?

What is the difference between music and noise?

How can a table increase the loudness of the sound made by a vibrating fork?

What characteristic of sound can you demonstrate with a piece of cardboard and a bicycle wheel?

Why does the pitch of a train whistle rise when the train comes toward you and drop when it moves away?

SOUND is a narrow stretch of water. There are several different kinds of such bodies of water. The word *sound* often describes a fiord or submerged glaciated valley, such as Howe Sound in British Columbia, or Doubtful Sound on South Island in New Zealand. The word sometimes denotes a deep, protected bay formed by the submergence of nonglaciated hilly land below sea level like Hingwha Sound on the southeastern coast of China. *Sound* is also used as a synonym for a strait, or narrow passage of water, between two broad areas of sea. Such straits include Kalmar Sound, separating the island of Öland from Sweden, and The Sound, or Øresund, which separates the Danish island of Sjaelland from Sweden. The word *sund* in the Danish, Norwegian, and Swedish languages means *sound.* J. Rowland Illick

See also Bay; Fiord; Strait.

SOUND BARRIER. See Sonic Boom.

SOUND EFFECT. See Radio (Putting a Show on the Air; picture: A Sound-Effects Expert); Motion Picture (Sound; picture: Recording Sound Effects).

SOUND-POWERED TELEPHONE is a communication device that operates only on the power of the sound that enters it. Telephones and most other communication systems operate on electrical power supplied by batteries or electric-power lines. However, the sound-powered telephone has no outside source of power other than that supplied by sound waves.

A sound-powered telephone system consists of two or more identical phone units connected by wires. Each phone consists of a metal diaphragm and a permanent magnet around which a coil is wound. The magnet is placed close to the diaphragm. This forms a type of microphone. When a person speaks into the microphone his voice causes sound waves that make the metal diaphragm vibrate. The coil and magnet transform the waves of sound into electrical impulses. These impulses are carried by wires to the other phone units in the system. There the coils and magnets pass on the electrical variations to the receiving diaphragms, causing them to vibrate and thus produce sound.

These telephones can work only over short distances, usually not more than about 15 miles (24 kilometers). Because no amplification is used, the speaker must talk close to the telephone and in a loud voice. But the sound-powered telephone has the advantages of being rugged, reliable, and inexpensive. Richard H. Bolt

SOUNDING. See Fathometer; Sonar.

SOUNDING LEAD. See Lead, Sounding.

SOUNDING ROCKET. See Space Travel (Space Probes).

SOUNDPROOFING. See Acoustics; Insulation.

SOUR GUM. See Black Tupelo.

SOURIS RIVER. See Assiniboine River.

SOURWOOD. See Sorrel Tree.

SOUSA, JOHN PHILIP (1854-1932), was a famous American composer and bandmaster. Sousa wrote many kinds of music, including operettas, orchestral suites, songs, waltzes, and a symphonic poem. But his fame rests on his marches, and he became known throughout the world as the "March King."

Sousa took the rather simple form of the military march and gave it a personal style and new rhythmic and melodic vitality. The best-known of his more than a hundred marches include "Semper Fidelis," "The Washington Post," "El Capitan," "Thunderer," "The High School Cadets," "Liberty Bell," "Manhattan Beach," "Hands Across the Sea," and "The Stars and Stripes Forever." A man of many gifts, Sousa also wrote five novels and an autobiography, *Marching Along* (1928).

Sousa was born in Washington, D.C. His parents could not afford to send him to Europe to study music. But Sousa later said, "I feel I am better off as it is . . . for I may therefore consider myself a truly American composer." After studying violin and harmony, he began his professional career at the age of 17, playing in theater and dance orchestras and touring with a variety show. In 1877, he played in Jacques Offenbach's orchestra when the famous French composer toured the United States. Soon afterward, Sousa wrote an operetta, *The Smugglers,* the first of many that he wrote in the next 35 years. He was one of the first Americans to compose operettas. He wrote the words as well as the music for these. The most successful of Sousa's operettas was *El Capitan* (1896).

John Philip Sousa composed many famous marches.

U&U

Sousa was appointed leader of the U.S. Marine Band in 1880, and made the band into one of the finest in the world. Some of the marches that made him famous were written for the band. In 1892, Sousa obtained his discharge from the Marine Corps and formed his own band.

Sousa gave concerts in America and Europe, playing arrangements of the classics as well as military marches. He was honored wherever he traveled. In England, King Edward VII decorated him with the Victorian Order. In 1900, the American writer Rupert Hughes wrote, "There is probably no other composer in the world with a popularity equal to that of Sousa." In 1910 and 1911, "Sousa's Band" made a triumphal world tour. From 1917 to 1919, Sousa served as bandmaster for the United States Navy. Gilbert Chase

SOUSAPHONE. See Tuba.

SOUSTER, RAYMOND (1921-), is a Canadian poet. He uses direct, simple language to make uncomplicated statements. Most of Souster's poems concern Toronto, where he was born and grew up. He writes about that city with both irony and sympathy.

More than a dozen collections of Souster's poetry have been published. He won the Governor General's Award for the collection *The Colour of the Times* (1964). In 1952, Souster helped found the Contact Press, which publishes the work of modern Canadian poets. He also edited an anthology of Canadian verse, *New Wave Canada: The New Explosion in Canadian Poetry* (1966). Souster wrote a realistic novel, *The Winter of Time* (1949), that was published under the pen name Raymond Holmes. Claude T. Bissell

SOUTH, THE. See Southern States.

SOUTH, UNIVERSITY OF THE. See Universities and Colleges (table).

Pete Turner, DPI

Scenic Cape Town, South Africa's legislative capital and oldest city, lies at the foot of Table Mountain. The Dutch founded the city in 1652 as a supply base for Dutch East India Company ships.

SOUTH AFRICA

SOUTH AFRICA is the richest and most highly developed country in Africa. It occupies only about 4 per cent of the continent's area and has only about 6 per cent of its people. Yet the country produces two-fifths of Africa's manufactured goods, nearly half its minerals, and a fifth of its farm products. South Africa generates more than half the continent's electricity and has about half its automobiles and half its telephones.

South Africa lies at the southern tip of the continent, between the Indian Ocean to the east and the South Atlantic Ocean to the west. The country is nearly three times as large as California and more than twice as large as France. It consists of four provinces—the Cape of Good Hope, which is usually called the Cape Province; Natal; the Orange Free State; and the Transvaal. South Africa has two capitals. Parliament meets in Cape Town, the legislative capital and the country's largest city. All government departments have their headquarters in Pretoria, the administrative capital.

The landscape varies dramatically throughout South Africa. There are high, sweeping plateaus, towering mountains, and deep valleys. Many picturesque beaches line the long, fertile coast. In addition to its scenic beauty, much of South Africa has a delightfully mild and sunny climate. Along the coast, such tropical and semitropical fruits as bananas, mangoes, and oranges thrive in the warm sun.

South Africa has one of the world's strongest and fastest-growing economies. It produces more gold and gem diamonds than any other country. It is also a leading producer of asbestos, chromium, copper, manganese, platinum, and uranium. South Africa's farmers produce almost all the food needed by the people. The country's mines and farms also produce nearly all the raw materials needed by industry. South Africa's factories turn out most of the country's clothing, processed foods, machinery, and other manufactured goods.

The people of South Africa form one of the most complicated racial patterns in the world. The country's government classifies the people into four main groups: (1) Bantu, (2) white, (3) Colored, and (4) Asian. The

Leonard M. Thompson, the contributor of this article, is Professor of History at Yale University, coeditor of The Oxford History of South Africa, *and the author of several books about South Africa.*

FACTS IN BRIEF

Capitals: Cape Town (legislative) and Pretoria (administrative).

Official Languages: Afrikaans and English.

Official Name: Republic of South Africa or, in Afrikaans, *Republiek van Suid-Afrika.*

Area (excluding Walvis Bay): 471,445 sq. mi. (1,221,037 km²). *Greatest Distances*—east-west, 1,010 mi. (1,625 km); north-south, 875 mi. (1,408 km). *Coastline*—about 1,650 mi. (2,655 km).

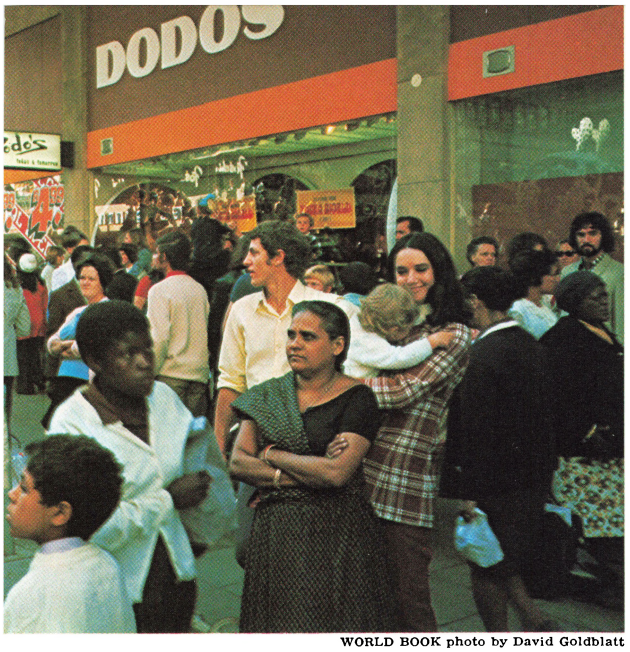
Elevation: *Highest*—Champagne Castle, 11,081 ft. (3,377 m) above sea level. *Lowest*—sea level along the coast.

Population (excluding Walvis Bay): *Estimated 1976 Population*—25,572,000; distribution, 52 per cent rural, 48 per cent urban; density, 54 persons per sq. mi. (21 persons per km²). *1970 Census*—21,448,169 (15,057,952 Africans; 3,751,328 whites; 2,018,453 Coloreds; 620,436 Asians). *Estimated 1981 Population*—29,216,000.

Chief Products: *Agriculture*—cattle, corn (maize), dairy products, fruits, sheep, sugar, wheat, wine, wool. *Manufacturing*—chemicals, clothing, metals, metal products, processed foods. *Mining*—asbestos, coal, copper, diamonds, gold, platinum, uranium.

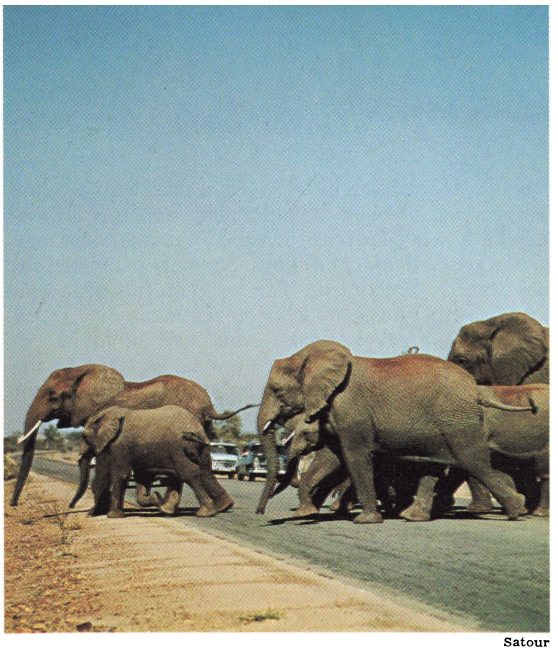
National Anthem: "Die Stem van Suid-Afrika" ("The Call of South Africa").

Money: *Basic Unit*—rand. For its value in U.S. dollars, see MONEY (table: Values).



WORLD BOOK photo by David Goldblatt

A Street Scene in Johannesburg, South Africa's chief industrial center, reflects the country's multiracial population.



Satour

Kruger National Park is South Africa's biggest tourist attraction. Elephants and other wild animals roam freely in the park.

Bantu, who are also called *Africans* or *blacks*, make up about 71 per cent of the population. The African people are further divided into eight subgroups, according to their traditional tribal divisions.

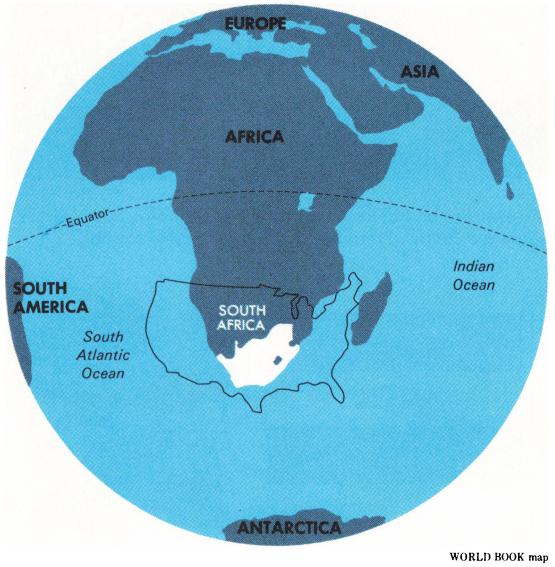
White people make up about 17 per cent of the population. They are split into two groups. About three-fifths of all whites are *Afrikaners*. Afrikaners are chiefly of Dutch descent and speak *Afrikaans*, a language developed from the Dutch language. The remaining two-fifths of the whites are mainly of British descent and speak English as their native language. Colored people make up about 9 per cent of the population. They are of mixed African, white, and Asian descent. Asians account for about 3 per cent of the population. The ancestors of almost all Asians came from India.

South Africa is one of the few countries in the world in which a racial minority controls the government. In South Africa, only whites may vote in parliamentary elections, serve in Parliament, and administer the laws. The government's official policy aims to keep the four racial groups strictly separated politically and socially. The government's goal is the "separate development" of each group. This policy is called *apartheid* (pronounced *ah PAHRT hayt*). *Apartheid* is an Afrikaans word meaning *apartness*.

Apartheid laws affect every aspect of life in South Africa. They determine where a person may live and go to school and what jobs he may hold. The laws forbid whites and nonwhites to eat in the same restaurants, stay in the same hotels, or ride on the same buses.

Almost every country, including the United States, has criticized the South African government's racial policies as a denial of basic human rights. The United Nations (UN) and the World Council of Churches have also denounced apartheid. South Africa has been excluded from taking part in the Olympic Games and many other international sports events.

Most white South Africans support segregation and resent outside criticism of their government. They say that South Africa is not only the most modern country in Africa but also the most stable. They claim that many nonwhites also favor segregation and that blacks in South Africa earn more money and have higher standards of living than do blacks in other countries of Africa. They also claim that Africans have the opportunity to learn the arts of government and, in time, become independent within their original homelands. Many people in Western Europe and the United States sympathize with the South African government. They regard the country as a strong defense against Communism and have found it highly profitable to invest in South African businesses.



WORLD BOOK map

South Africa lies at the southern tip of Africa. It has an area about 16 per cent as large as that of the United States, not including Alaska and Hawaii.

South Africa is a republic, with a president, a prime minister and Cabinet, a Parliament, and a court system. Only white citizens 18 years of age and older may vote in parliamentary elections, and only white persons may serve in Parliament. The table on this page outlines the structure of the white government.

Nonwhite Governments. Apartheid prohibits Africans, Asians, and Coloreds from taking part in the white South African government. Instead, Parliament has set up separate organizations for these groups.

The government regards South Africa's black populations as eight separate *nations*, each with its own ancestry and culture. These nations, such as the Xhosa and Zulu, have been assigned reserves in their original homelands. The reserves consist of scattered blocks of land in eastern South Africa. They cover about 13 per cent of the country's area. As the nations develop on their reserves, the government says it will grant them increased powers leading, in time, to independence.

In 1963, the Transkei—the homeland of the Xhosa—became the first reserve to receive a degree of self-rule. The Transkei has a chief minister, Cabinet, and Legislative Assembly. The Assembly has 109 members. Xhosa citizens elect 45 of them. The remaining 64 members are Bantu chiefs. The Transkei government may not make any laws that conflict with those passed by Parliament.

Both Colored people and Asians have a council. The Colored Persons Representative Council consists of 40 elected and 20 government-appointed members of the Colored community. Laws made by the council may not conflict with those passed by Parliament. The South African Indian Council has 25 government-appointed members of the Indian community. It may only advise the government on matters of direct concern to Indians.

GOVERNMENT IN BRIEF

Form of Government: Republic.

Head of State: President, who is elected by Parliament to a 7-year term.

Head of Government: Prime minister, who is usually the leader of the majority party in Parliament. He and his Cabinet set government policies. Cabinet members head the government departments and must be members of Parliament.

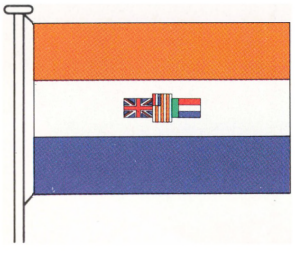
Parliament: *House of Assembly*—166 members elected by qualified voters. *Senate*—43 members elected by the Assembly and provincial legislatures and 11 members appointed by the president. Parliament members serve 5 years unless Parliament is dissolved sooner.

Courts: The highest court, the Appellate Division of the Supreme Court, hears only appeals. Provincial and local divisions of the Supreme Court hear original cases and appeals from the lowest courts, the magistrates' courts.

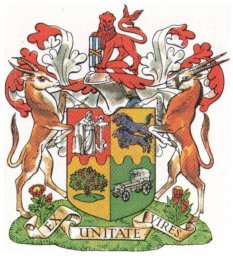
Provincial Government: A provincial council, elected by white voters, deals with local matters in each province. An administrator appointed by the president serves as chief executive. Council members and administrators serve 5-year terms.

Harrison Forman

The Houses of Parliament stand in Cape Town, South Africa's legislative capital. Pretoria is the administrative capital.



The South African Flag, adopted in 1927, features the British Union Flag and flags of the two former Boer republics.



Coat of Arms. Symbols on the shield represent South Africa's four provinces. *Ex Unitate Vires* means *Unity Is Strength.*

Political Parties. The National Party has controlled the South African government since 1948. The party stands for apartheid and has the support of most Afrikaners and some English-speaking whites. The main opposition party, the United Party, favors a somewhat less strict apartheid policy. Most English-speaking whites and a few Afrikaners support the party. South Africa also has two smaller parties. The Reconstructed National Party wants an even stricter apartheid policy than that of the National Party. The Progressive Party favors sharply reducing racial bars.

The government prohibits interracial political parties. African parties are allowed within the homelands, and Colored parties compete for election to their council. Indians have no elected members on their council and no political organization of their own.

South West Africa is a former German colony administered by South Africa. It borders South Africa on the northwest. The League of Nations placed the territory under South Africa's control in 1920. The UN has condemned South Africa for applying its apartheid policy there and has voted to end the country's control of the territory. But South Africa refuses to give up South West Africa and governs it much like a province. See SOUTH WEST AFRICA.

Armed Forces. South Africa has about 17,000 white men in its army, air force, and navy. In an emergency, an additional 92,000 trained whites can quickly be called into service. White males between 16 and 25 must receive military training. Nonwhites do not have to serve in the military.

Population and Ancestry. In 1976, South Africa had about 25½ million persons. Almost half the people live in urban areas. The country has three cities with more than 500,000 persons. They are, in order of size, Cape Town, Johannesburg, and Pretoria. South Africa has 12 other cities with over 100,000 persons. The country's cities rank among the most modern and beautiful in the world. See the separate articles on the cities of South Africa listed in the *Related Articles* at the end of this article.

The government divides South Africans into four major racial groups. In order of political and social importance, whites rank first, followed roughly by Coloreds, Asians, and Africans. The government issues each citizen a document showing which group he or she belongs to. But no group is "racially pure." For example, many people classified as Bantu (African) have some white or Asian ancestry. Many people classified as white have some African or Asian ancestry. By definition, Colored people have a mixed ancestry, which varies greatly among individuals. The government classifies individuals on the basis of appearance, known ancestry, and the opinion of other persons in the community.

Whites. About 4½ million white persons live in South Africa. Afrikaners make up about three-fifths of the white population. Their ancestors came chiefly from The Netherlands, Germany, and France during the late 1600's and 1700's. Until the 1900's, most Afrikaners lived on farms and were called *Boers*. *Boer* is a Dutch word meaning *farmer*. Today, most Afrikaners live in cities, but they still make up most of the white population in rural areas. English-speaking whites account for about two-fifths of South Africa's white citizens. Their ancestors came chiefly from England, Ireland, and Scotland beginning in the 1800's.

Colored People total about 2¼ million. Their ancestors include various peoples. Some were yellowish-skinned hunters and herders who lived in western South Africa when the first white settlers arrived in the 1600's. Some were Negro and Southeast Asian slaves brought to the country after the whites came. Other ancestors include the early white settlers themselves and passing sailors, soldiers, and travelers.

Asians. About ¾ million Asians live in South Africa. The ancestors of almost all of them came from India between 1860 and 1911. They came to work, under contract, on the sugar plantations in Natal.

Africans total about 18 million. Their ancestors probably began to move into what is now eastern South Africa from the north before A.D. 1000.

John Rushmer from Carl Östman

Afrikaner Farmers attend a sheep sale. Afrikaners, who are mainly of Dutch descent and speak Afrikaans, largely control South Africa's government and agriculture. They and English-speaking whites make up about 17 per cent of the population.

Languages. South Africa has two official languages —Afrikaans and English. The government uses both languages for official business, and both are taught in white schools. Afrikaans developed from Dutch, but it also has words from other European languages and from Asian and African languages. South African English resembles standard English with many Afrikaans words. In their homes, almost all Afrikaners speak only Afrikaans, and almost all other whites speak only English. About 90 per cent of the Colored people speak Afrikaans, and the rest speak English. Asians speak various Indian languages, though most also know English. Africans speak a variety of Bantu languages. Many Africans also speak a little Afrikaans or English.

Ways of Life. The government's apartheid policy encourages whites, Africans, Coloreds, and Asians to keep and develop their own way of life. The people in each group must live in separate areas, and children must go to separate schools. The groups are also separated in the jobs they may hold and in their recreational activities. But whites employ large numbers of nonwhites in their homes, industries, and businesses. Each group's way of life thus reflects not only its inherited traditions but also the fact that it must associate with other groups in economic activities.

Differences exist within each racial group as well as between the groups. In each group, some people have better jobs and make more money than others. Even in the African, Asian, and Colored communities—which have many very poor people—there are successful businessmen and professional persons. Political differences also exist within the groups. For example, most whites vote for politicians who support apartheid, but some vote for candidates who oppose the policy. Some Africans would like to drive the whites out of the country. Yet other Africans believe in cooperating with whites to build a new society without racial bars.

Whites. About 87 per cent of all white South Africans live in urban areas. Most whites have a high standard of living. Their clothing, homes, and social customs resemble those of middle-class Americans and Europeans. Many whites live in luxurious suburban areas of Cape

Marvin Newman, DPI

English-Speaking Whites largely control South Africa's businesses and industry. Chiefly of British descent, they still follow many British traditions, such as a love for horse shows, above.

Town, Durban, Johannesburg, and Pretoria. Most white families live in single-family homes, and many have at least one African, Asian, or Colored servant.

Afrikaners and English-speaking whites generally lead separate lives. They live in different sections of a city and belong to different churches and social and professional organizations. Afrikaners hold nearly all the government jobs in South Africa, and they control most of the nation's agriculture. On the other hand, English-speaking whites largely control the nation's businesses and industries.

Colored People. About 75 per cent of South Africa's Coloreds live in cities. The Colored community began in the Cape Province, and almost all Coloreds still live there. Colored people have worked for whites for many generations. As a result, they have no traditions of their own and live as much like whites as they can afford. Coloreds would like whites to accept them as equals. Within their group, the lighter a person's skin is, the more highly he is regarded. In the cities, most Colored people work as servants, factory laborers, or craftsmen. In rural areas, many work in vineyards or orchards.

Asians. About 85 per cent of all Asians live in cities. The great majority of Indians, who make up almost all the Asian population, live in Natal. Indians have kept many of their old customs. Most Indians are Hindus and largely observe the *caste system* of their religion, which divides them into social classes. Women still wear the traditional *sari*—a long piece of cloth draped around the body. But young people and many men wear Western-style clothing. Most Indians are poor and work in factories or grow vegetables for big-city markets. But a few Indians have become prosperous doctors, industrialists, lawyers, and merchants.

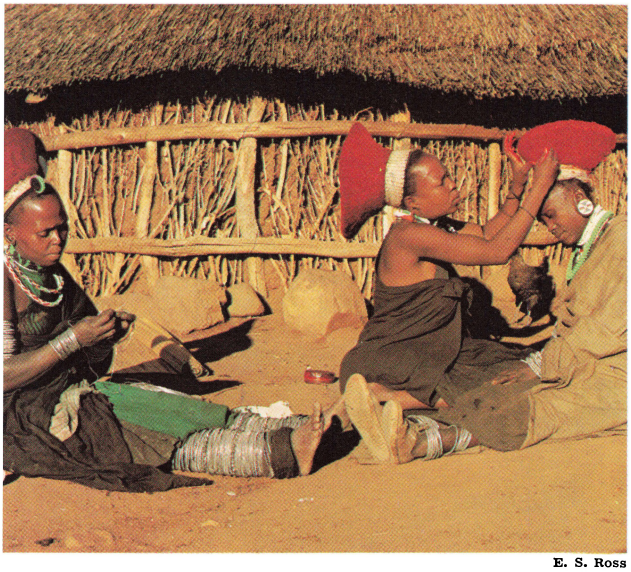
Africans. The government considers every African to be a citizen of his particular homeland. But only about 45 per cent of all Africans live in their homelands. The rest live in cities, on white farms, or near the country's mines. On their reserves, many Africans follow a traditional way of life. They honor their chiefs and hold tribal ceremonies. The men herd cattle, and the women tend crops. They live in round, thatch-roofed houses, dress their hair in elaborate styles, and wear colorful costumes.

Many African men cannot make a living for their families on the reserves. They must periodically leave their homeland to work in white areas. Generally, their families may not go with them. These migrant laborers spend their lives circulating between the traditional society in which they were born and the mines and factories where they find work. Many other Africans have always lived in cities. In general, they follow Western customs and traditions.

Food and Drink vary among the people of South Africa according to their wealth and customs. Whites enjoy foods much like those eaten by Americans and Europeans. They also eat local specialties, such as *boerewors*, an Afrikaner sausage dish, and *curry*, an Indian dish of eggs, fish, meat, or vegetables cooked in a spicy sauce. The diet of Colored people is like that of whites but less costly. Indians enjoy curry and other traditional dishes. The basic food of Africans is *mealies* (corn), which they eat as a porridge. Many Africans

E. S. Ross

A Group of Colored Schoolchildren reflect the mixed ancestry of South Africa's Colored community. Coloreds make up about 9 per cent of the population. Almost all live in the Cape Province.



E. S. Ross

Africans make up about 70 per cent of South Africa's people. Nearly half of them, like these Zulu, live on reserves. There, many Africans keep their old customs. For example, the elaborately dressed, red-dyed hair of these women indicates they are married.

suffer from a shortage of proteins and vitamins.

Popular beverages include coffee, tea, and soft drinks. White people enjoy the fine wines that come from the Cape Province. All groups drink the beer made by their country's breweries.

Recreation. South Africans love sports, and the country's mild climate enables them to spend much of their leisure time outdoors. Their favorite games come from England. They include Rugby football—South Africa's national sport—cricket, and association football (soccer). Other popular sports include golf, surfing, swimming, and tennis. On weekends and holidays, many city dwellers flock to the beaches or tour their country's national parks and game reserves.

All South Africans engage in the same kinds of recreational activities. But like everything else, apartheid affects these activities. Beaches, sports facilities, and theaters are all segregated. In addition, nonwhite facilities are poor compared with those for whites. Whites and nonwhites may not play on the same sports teams. But occasionally, white and nonwhite teams may compete against each other.

Education. South African students in each racial group attend separate schools. In addition, most English- and Afrikaans-speaking white children go to separate schools, but both groups must learn both languages. On a per child basis, the government spends far more money on the education of white children than on that of nonwhites.

White children from age 7 to 16 must attend school. More than 90 per cent go to public schools. The rest attend government-supervised private schools. About 55 per cent of the white children complete high school.

Colored and Asian children aged 7 to 14 must go to school if they live in areas where facilities are available. Many areas have a shortage of schools and classrooms for Coloreds and Asians. More than 99 per cent of the children who go to school attend public schools. The rest attend church-supported schools supervised by the government. About 10 per cent of the Colored children and 25 per cent of the Indian children go on to high school. The law does not require African children to go to school. Yet about 80 per cent of them between ages 7 and 14 do attend school. However, most South African blacks do not complete primary school.

South Africa has 11 universities for whites, 3 for Africans, and 1 each for Coloreds and Asians. Students enrolled at the universities include about 73,000 whites, 4,600 Africans, 3,500 Asians, and 1,900 Coloreds.

Religion. South Africa does not have an *established* (national) church. But most Afrikaners, who largely control the government, belong to the Dutch Reformed Church or to its sister churches. As a result, this church is often identified with the government. Most English-speaking whites belong to the Anglican, Congregational, Methodist, or Roman Catholic churches.

In religion, as in other areas, Colored people have adopted white traditions. Most belong to the Anglican, Congregational, Dutch Reformed, Methodist, or Roman Catholic churches. Most Asians are Hindus or Moslems.

About 30 per cent of the African people belong to national or international Christian churches, chiefly the Anglican, Dutch Reformed, Lutheran, Methodist, and Roman Catholic churches. Many other Africans follow tribal religions. They believe that the spirits of their ancestors affect their lives for good or evil. They try to influence the spirits through animal sacrifices. About 15 per cent of all Africans belong to *independent Christian churches*. Many of these churches combine Christian and tribal beliefs.

The Arts. The South African government supports a performing arts council in each province. The councils have English and Afrikaans companies that present ballets, concerts, operas, and plays in small towns as well as big cities. Private African, Asian, Colored, and white companies also perform dramas, musicals, and other works throughout the country.

South Africa has produced outstanding artists in such fields as ballet, music, painting, and sculpture. But its greatest contribution to the arts has been in literature. Much of South Africa's literature reflects the country's political and social tensions. After the Anglo-Boer War of 1899-1902, such Afrikaner writers as Jan Celliers, C. L. Leipoldt, and C. J. Langenhoven expressed their sorrow over Great Britain's conquest of their land.

Since the 1920's, many South African writers have dealt with racial themes. They include the white authors Nadine Gordimer, Alan Paton, and William Plomer; the Colored novelist Peter Abrahams; and the African writers Ezekiel Mphahlele and Benedict Vilakazi. Over the years, the government has taken increased measures to prevent artists from criticizing its apartheid policy or from writing freely on many other subjects. Today, many South African writers cannot publish in their native land.

South Africa occupies the southern tip of Africa. It covers 471,445 square miles (1,221,037 square kilometers), excluding Walvis Bay, an area of 434 square miles (1,124 square kilometers) in South West Africa that belongs to South Africa. The small, independent country of Lesotho lies entirely within South Africa.

Land Regions

The country has five land regions: (1) the Plateau, (2) the Coastal Strip, (3) the Cape Mountains Region, (4) the Kalahari Desert, and (5) the Namib Desert.

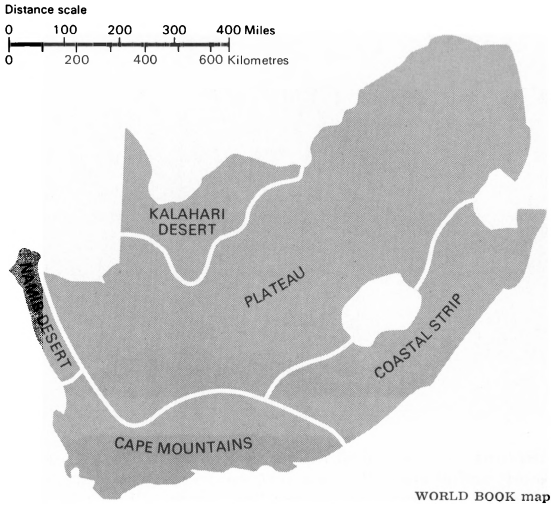
The Plateau covers most of the interior of South Africa. The *Great Escarpment*, a semicircular series of cliffs and mountains, rims the Plateau and separates it from the coastal regions. The escarpment reaches its greatest heights—over 11,000 feet (3,350 meters) above sea level—in the Drakensberg mountain range in the east. The country's highest point, 11,081-foot (3,377-meter) Champagne Castle, rises in the Drakensberg.

The Plateau slopes gradually downward from the escarpment. It has three chief subregions—the Highveld, the Middleveld, and the Transvaal Plateau Basin. The *Highveld* occupies all the Plateau except for the northwestern and northeastern corners. It lies mostly between 4,000 and 6,000 feet (1,200 and 1,800 meters) above sea level and consists largely of flat, grass-covered land. In places, flat-topped mountains rise above the plain. The area around Johannesburg is called the *Witwatersrand* or *Rand*. It covers over 1,000 square miles (2,600 square kilometers) and is the world's largest and richest gold field. This area is the nation's chief industrial and business center. Farmers in the Highveld raise cattle, corn, fruits, potatoes, and wheat.

The *Middleveld*, in the northwestern part of the Plateau, averages less than 4,000 feet (1,200 meters) above sea level. It is a dry, flat area and serves largely as ranch country. The *Transvaal Plateau Basin* forms the plateau's northeastern part. It also averages less than 4,000 feet above sea level, though it has mountain ranges 6,000 feet (1,800 meters) high. The area is largely a rolling grassland with scattered thorn trees. Farmers raise citrus and other fruits, corn, and tobacco. Kruger National Park, a world-famous game reserve, lies in the area. Elephants, leopards, lions, zebras, and other wild animals roam freely in the park, which is South Africa's most popular tourist attraction.

LAND REGIONS OF SOUTH AFRICA

The map below shows the five land regions of South Africa: the Kalahari Desert; the Namib Desert; the Plateau; the Cape Mountains; and the Coastal Strip.



WORLD BOOK map

SOUTH AFRICA MAP INDEX

Provinces

CAPE OF GOOD HOPE ..... 6,721,849 ..... D 2
NATAL ..... 4,245,675 ..... C 5
ORANGE FREE STATE ..... 1,715,589 ..... C 4
TRANSVAAL ..... 8,765,056 ..... B 4

Cities and Towns

Aliwal North ... 12,178 .. D 4
Barberton . 12,232 .. C 5
Beaufort West ..... 17,730 .. D 3
Benoni ... 149,563 *162,794 .. C 4
Bethal* .... 17,116 .. C 4
Bethlehem . 29,460 .. C 4
Bloemfontein .... 148,282 *180,179 .. C 4
Boksburg* 104,171 .. C 4
Brakpan .. 113,115 .. C 4
Brits* ..... 11,990 .. C 4
Burgersdorp . 8,197 .. D 4
Cape Town 691,296 *1,096,597 .. D 2
Carletonville* .... 40,641 .. C 4
Ceres ..... 9,104 .. D 2
Cradock .... 20,522 .. D 4
De Aar .... 17,823 .. D 3
Despatch* .. 12,952 .. D 4
Dundee .... 15,614 .. C 5
Durban ... 495,458 .... *843,327 .. C 5
East London . 118,298 *123,294 .. D 4
Ermelo .... 18,759 .. C 5
Estcourt ... 10,789 .. C 4
Ficksburg ... 9,283 .. C 4
Fort Beaufort . 11,504 .. D 4
George ..... 24,395 .. D 3
Germiston 210,298 .. C 4
Glencoe .... 10,371 .. C 5
Graaff-Reinet ... 22,065 .. D 3
Grahamstown ..... 41,086 .. D 4
Greytown* .. 8,730 .. C 5
Harrismith . 15,535 .. C 4
Heidelberg* 13,140 .. C 4
Heilbron .... 6,687 .. C 4
Hennenman* 6,905 .. C 4
Johannesburg .... 654,682 *1,432,643 .. C 4
Kempton Park* .... 35,767 .. C 4
Kimberley 103,789 .. C 3
King William's Town .... 15,429 .. D 4
Klerksdorp . 75,276 .. C 4
Knysna .... 13,304 .. D 3
Kokstad .... 9,268 .. D 4
Kroonstad 50,898 .. C 4
Krugersdorp 91,202 .. C 4
Kuruman . 5,652 .. C 3
Ladybrand* . 8,731 .. C 4
Ladysmith . 28,554 .. C 4
Lichtenburg* .... 13,566 .. C 4
Louis Trichardt . 8,816 .. B 4
Lydenburg .. 7,308 .. C 5
Mafeking ... 6,493 .. C 4
Malmesbury 9,466 .. D 2
Mariannhill* .... 22,075 .. C 5
Messina ... 11,914 .. B 5
Meyerton* .. 8,492 .. C 4
Middelburg 10,818 .. D 4
Middelburg* 26,577 .. C 4
Mosselbaai . 17,359 .. D 3
Nelspruit .. 24,744 .. C 5
Newcastle .. 14,216 .. C 4
Nigel* ..... 33,850 .. C 4
Noupoort ... 7,256 .. D 3
Nylstroom ... 6,787 .. B 4
Odendaalsrus . 15,344 .. C 4
Orkney* ... 21,994 .. C 4
Oudtshoorn 26,525 .. D 3
Paarl ..... 48,597 .. D 2
Parys* ..... 16,957 .. C 4
Pietermaritzburg . 112,666 *158,921 .. C 5
Pietersburg 27,058 .. B 4
Piet Retief . 10,098 .. C 5
Port Alfred . 8,524 .. D 4
Port Elizabeth .... 386,577 *468,577 .. D 4
Potchefstroom .. 55,296 .. C 4
Potgietersrus .... 6,550 .. B 4
Pretoria .. 543,950 *561,703 .. C 4
Prieska ..... 8,367 .. C 3
Queenstown 39,552 .. D 4
Randfontein* .... 32,527 .. C 4
Robertson .. 10,131 .. D 2
Roodepoort-Maraisburg .... 114,191 .. C 4
Rustenburg 21,915 .. C 4
Sasolburg* . 28,654 .. C 4
Senekal* .... 9,013 .. C 4
Somerset East ..... 10,246 .. D 4
Somerset West* ... 11,911 .. D 2
Springs .... 99,047 *104,090 .. C 4
Standerton . 20,782 .. C 4
Stanger .... 10,899 .. C 5
Stellenbosch* .. 29,666 .. D 2
Stilfontein* 13,392 .. C 4
Strand ..... 24,254 .. D 2
Stutterheim . 6,801 .. D 4
Tongaat* .. 12,772 .. C 5
Uitenhage .. 69,048 .. D 4
Umtata .... 24,838 .. D 4
Upington .. 28,234 .. C 3
Vanderbijlpark* .... 78,754 .. C 4
Vereeniging .. 169,553 .. C 4
Virginia ... 45,842 .. C 4
Volksrust .. 10,034 .. C 4
Vrede* ..... 6,251 .. C 4
Vryburg ... 16,673 .. C 3
Vryheid .... 16,842 .. C 5
Walvis Bay . 21,725 .. B 1
Warmbad ... 8,280 .. B 4
Welkom ... 66,217 *131,767 .. C 4
Wellington* 16,844 .. D 2
Westonaria* 36,030 .. C 4
Witbank ... 36,923 .. C 4
Wolmaransstad* ..... 7,214 .. C 4
Worcester .. 40,610 .. D 2
Zeerust ..... 6,895 .. C 4

Physical Features

Algoa Bay ..... D 4
Cape Agulhas ..... D 3
Cape of Good Hope . D 2
Drakensberg (Mountains) ..... D 4
Great Karroo (Plateau) ..... D 3
Grootvloer ..... C 3
Kalahari Desert .... B 3
Kruger National Park ..... B 5
Little Karroo (Plateau) ..... D 3
Molopo River ..... C 3
Mont aux Sources (Mountain) ..... C 4
Namaqua Highlands C 2
Northern Karroo (Plateau) ..... C 4
Olifants River ..... B 5
Orange River ..... C 2
Saint Helena Bay .. D 2
Transvaal Low Veld B 5
Vaal River ..... C 4
Verneukpan ..... D 3
Witwatersrand ..... C 4

*Population of metropolitan area, including suburbs.
*Does not appear on the map; key shows general location.

Source: Latest census figures (1970).

Specially created for **World Book Encyclopedia** by Rand McNally and World Book editors

Gordon Douglas

South Africa's Magnificent Scenery includes deep valleys, towering mountains, and broad plateaus. Typical Zulu huts, above, dot the Zulu homeland in the Coastal Strip, which extends along the southeast coast. The lofty Drakensburg mountain range rises in the background.

The Coastal Strip extends along the southeast coast from Mozambique to the Cape Mountains Region. Except in the northeast, the region has little low-lying land. In the Durban area, for example, the land rises to 2,000 feet (610 meters) within 20 miles (32 kilometers) of the sea. Chief crops include bananas, citrus fruits, sugar cane, and vegetables. Durban, East London, and Port Elizabeth thrive as resorts, industrial centers, and ports.

The Cape Mountains Region stretches from the Coastal Strip to the Namib Desert. The region's mountains run north to south in the west and east to west in the south. They meet at right angles northeast of the great industrial and port city of Cape Town. Between the mountains and the Great Escarpment lie two dry tablelands—the *Little Karroo* and the *Great Karroo*. There, farmers irrigate wine grapes and other fruits. They also raise wheat and many sheep.

The Namib and Kalahari Deserts. The Namib lies along the Atlantic Ocean north of the Cape Mountains Region and extends into South West Africa. The Kalahari lies north of the Middleveld and extends into the country of Botswana. Small bands of hunters roam the deserts, living on the plants and animals they find.

Rivers

South Africa's longest river is the Orange River. It begins in Lesotho and flows westward about 1,300 miles (2,090 kilometers) into the Atlantic. The Vaal River, the Orange's largest branch, rises in southeastern Transvaal. It flows about 750 miles (1,210 kilometers) before joining the Orange in the Cape Province. The Limpopo River begins near Johannesburg and winds about 1,000 miles (1,600 kilometers) across eastern South Africa and Mozambique before emptying into the Indian Ocean. South Africa also has many shorter rivers. But sand bars and the shallowness of the water make it impossible for ships to use any of the rivers. See LIMPOPO RIVER; ORANGE RIVER; VAAL RIVER.

Climate

South Africa lies south of the equator, and so its seasons are opposite those of countries in the Northern Hemisphere. Most of South Africa enjoys a mild, sunny climate. But differences in elevation, the wind systems, and ocean currents affect the climate in various areas. For example, the Cape Mountains Region has warm, dry summers and cool, wet winters. Much of the Coastal Strip has hot, humid summers and dry, sunny winters. In the eastern Plateau, summer days are hot, but the nights are cool. In winter, the days are crisp and clear, and the nights are cold. Winter temperatures throughout most of the Plateau often drop below freezing.

Only about a fourth of South Africa receives more than 25 inches (64 centimeters) of rain a year. Most of the rain falls in summer. In general, rainfall decreases from east to west. Parts of the east coast receive over 40 inches (100 centimeters) annually. In the west, the Namib Desert gets almost no rain.

The first European farmers arrived in South Africa in the 1650's. For the next 200 years, the country's economy depended mainly on the raising of livestock and crops. Then in the late 1800's, diamonds and gold were discovered. Mining quickly became the basis of South Africa's economy. Mining also started the country on its way to becoming the industrial giant of Africa.

There have been several reasons for South Africa's spectacular industrial growth. The government actively encourages and provides funds for industrial development. It also seeks foreign investments by advertising the safety of—and the high return on—such investments. As a result, many people in the United States and other countries have put money into South African businesses. The country's growth has also been spurred by its wealth of natural and human resources. South Africa has raw materials needed for industry and a huge labor force, including many skilled managers.

Natural Resources. South Africa has long been famous for its fabulous deposits of gold and diamonds. It also has large supplies of asbestos, chromite, coal, copper, iron ore, manganese, platinum, silver, and uranium (as a by-product of gold). In fact, the country has nearly every useful mineral except oil.

South Africa is less fortunate in some other natural resources. Only a third of the farmland receives enough rain to grow crops easily. South Africa also has poor forest resources. It also has no natural harbors. But the offshore waters provide plentiful fish and help make South Africa a leading fishing country.

Manufacturing. South Africa's factories produce almost all the country's manufactured goods. The chief products include chemicals, clothing, iron and steel and other metals, metal products, and processed foods. Most factories are in the Cape Town, Durban, Johannesburg, Port Elizabeth, and Pretoria areas. But labor is scarce in these areas because the government limits the number of Africans who may work there. The government offers industrialists financial help and other benefits if they set up new factories on the borders of the African homelands.

Mining. South Africa ranks as one of the world's chief mining countries. It has long produced most of the world's gold. It is also a top producer of asbestos, chromite, copper, diamonds, manganese, platinum, and uranium. Miners also dig dozens of other minerals.

Ever since its discovery in the 1880's, gold has been the main force behind South Africa's growth. Gold mining has produced enormous income for the country and attracted huge foreign investments. Directly or indirectly, gold mining has led to the development of the railroads and many manufacturing industries.

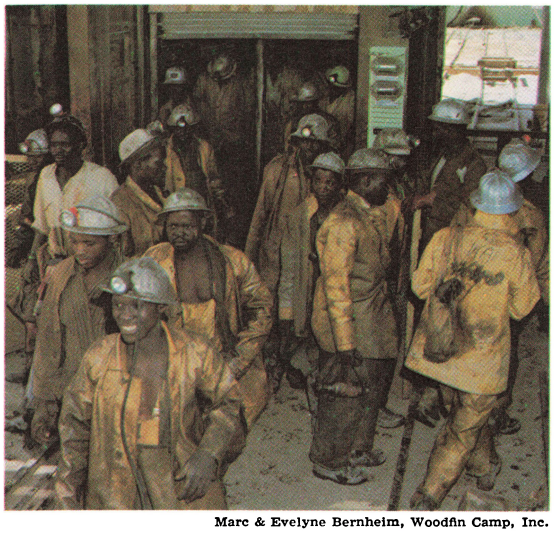
Agriculture. South Africa's farmers produce almost all the food needed by the people. The leading crops include corn, fruits, sugar cane, and wheat. South Africa ranks as one of the world's chief sheep-raising countries, and wool is its main agricultural export. Other farm animals include beef and dairy cattle.

South Africa has two types of farming—that practiced by whites and that practiced by Africans on the reserves. White farmers use modern methods and raise products chiefly for market. Their farms range from fewer than 100 acres (40 hectares) to sheep ranches of more than 10,000 acres (4,000 hectares). The average size is about 2,300 acres (931 hectares).

On the reserves, African farm families produce food mainly for their own needs. The land available for each family averages about 52 acres (21 hectares). Production is extremely low. Critics of the government say productivity is low because the reserve farmlands are too small and their soils too poor to support the African population. Government officials say the lack of progress results from Africans' refusal to give up their traditional farming methods for modern techniques.

WORLD BOOK photo by David Goldblatt

The Fast-Growing Electronics Industry symbolizes South Africa's modern industrial economy. Workers at this plant are producing equipment for use in underground telephone cable systems.



Marc & Evelyne Bernheim, Woodfin Camp, Inc.

Gold Mining has long provided enormous wealth for South Africa, the world's leading gold producer. Hundreds of thousands of men, most of them Africans, work in the country's gold mines.

Labor Force of South Africa is divided along racial lines. Whites do almost all the high-paid, skilled work. They hold nearly all the executive, professional, and technical jobs in South Africa. Nonwhites do almost all the low-paid, unskilled work. Africans, who are extremely low-paid, serve largely as manual laborers in factories, on white farms, and in mines. Most Asians and Coloreds serve as domestic or hotel help or work on farms or in factories.

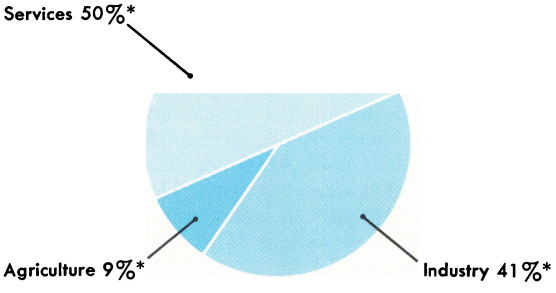
The racial division in the labor force has always existed in South Africa. But over the years, it has been strengthened by social attitudes, differences in education, laws, and government policies. One of these policies is the *job reservation system*, which reserves certain jobs for certain races. As a result of this racial division, South Africa has a shortage of skilled workers and an abundance of unskilled workers. This shortage has led to some easing of the job reservation rules.

Harrison Forman

A Cargo of High-Quality Corn has been loaded for export at the Port of East London. Corn, or maize, ranks as South Africa's main crop and one of its leading agricultural exports.

SOUTH AFRICA'S GROSS NATIONAL PRODUCT

Total gross national product in 1971—$17,153,000,000



The gross national product (GNP) is the total value of goods and services produced by a country in a year. The GNP measures a nation's total annual economic performance. It can also be used to compare the economic output and growth of countries.

PRODUCTION AND WORKERS BY ECONOMIC ACTIVITIES

Economic Activities	Per Cent of GDP* Produced	Employed Workers	
		Number of Persons	Per Cent of Total
Manufacturing	23	1,202,400	17
Wholesale & Retail Trade	14	485,800†	7
Finance, Insurance, & Real Estate	11	85,000	1
Mining	10	661,500	10
Government	10	661,300	10
Agriculture, Forestry, & Fishing	9	1,800,000†	26
Transportation & Communication	9	285,500	4
Construction	5	383,300	6
Other	4	—	—
Utilities	3	**	**
Community, Business, & Personal Services	2	1,300,000†	19
Total	100	6,864,800	100

*Gross domestic product for 1970, latest information available. GDP is gross national product adjusted for net income sent or received from abroad.
†1969, latest information available.
**Included with Finance, Insurance, & Real Estate.
Sources: Information Service of South Africa; South African Reserve Bank.

Trade. South Africa's biggest customer and biggest supplier has long been Great Britain. Other trading partners include Japan, the United States, Western European nations, and neighboring African countries. South Africa's chief exports include gold, diamonds, food, metals and minerals, and wool. Machinery and transportation equipment make up nearly half the value of the country's imports. Other imports include chemicals, food, manufactured goods, and petroleum.

Transportation. South Africa has the best transportation system in Africa. About 200,000 miles (320,000 kilometers) of roads crisscross the country. Of these roads, about 17,000 miles (27,400 kilometers) are surfaced. The government-owned South African Railways operates the country's 14,000 miles (22,500 kilometers) of railroad track. South African Airways, the government-owned national airline, provides domestic and international service. About 15 major overseas airlines also serve the country. South Africa has four large, well-equipped ports—Cape Town, Durban, East London, and Port Elizabeth. A new harbor is also being built at Richards Bay in northern Natal.

Communication. South Africa has 22 daily newspapers, of which 16 are published in English and 6 in Afrikaans. The largest English-language daily, the Johannesburg *Star*, has a circulation of more than 177,000 copies. *Die Burger*, published in Cape Town, is the largest Afrikaans daily. It sells over 52,000 copies.

The government owns South Africa's 11 radio stations, which broadcast in Afrikaans, English, and several Bantu languages. Government television broadcasting is to begin in the mid-1970's. The government also runs the postal, telegraph, and telephone systems.

The Publications Control Board, a government body, reviews all books, films, plays, and other *publications*. It decides if a publication is obscene, deals excessively with violence or racial conflict, or promotes Communism. The board has prohibited thousands of publications for moral or political reasons.

E. S. Ross

Rock Painting once flourished among the San, or Bushmen. These yellowish-skinned hunting people lived in South Africa long before the first white settlers arrived in the 1600's. Today, only scattered groups of San survive in remote desert regions of South Africa and neighboring countries. But their excellent rock paintings, which have become of great interest to scientists and tourists, can still be found in caves and rock shelters throughout South Africa.

Manlike creatures lived in what is now South Africa as long as 2 million years ago. By at least 2,000 years ago, human beings lived throughout much of the region. These people hunted animals and gathered wild plants.

By A.D. 1500, great changes had occurred in the western and eastern parts of South Africa. The western part was thinly occupied by two groups of yellowish-skinned people, who were descendants of the earlier hunting people. One group, the *San*, lived by hunting. The other group, the *Khoikhoi*, raised cattle and sheep. When the Europeans arrived in the 1600's, they called the San *Bushmen* and the Khoikhoi *Hottentots*.

Meanwhile, eastern South Africa had become more heavily populated by brown-skinned people who spoke various Bantu languages. They began to enter the region from the north about A.D. 900. They lived in chiefdoms, raised cattle and sheep, and grew grain.

Settlement by the Dutch. Portuguese sailors became the first Europeans to see South Africa. They sighted it in 1488, when they rounded the Cape of Good Hope in their search for a water route to India.

The first European settlers arrived in 1652. They worked for the Dutch East India Company. The company sent the group, headed by Jan van Riebeeck, to set up a supply base at the present site of Cape Town. The base was to serve as a halfway station where company ships could pick up food and water on the way to and from the East Indies. Soon after the base was set up, the company imported slaves from tropical Africa—and later from Southeast Asia—to work on its farms.

In 1657, the Dutch East India Company began to allow some employees to leave the firm and start their own farms. These people became known as *Boers* (farmers). In 1679, the company also began to offer free passage and land to new settlers from Europe. More Dutch farmers, as well as French and German settlers, joined the Cape Colony. By 1700, whites occupied most of the good farmland around Cape Town. Then they moved into drier areas and became sheep and cattle ranchers. As the white territory expanded, the Khoikhoi and San population declined. The whites killed some Khoikhoi and San, and many others died of smallpox. Most survivors became servants of the whites.

By 1795, the whites had spread about 300 miles (480 kilometers) north and over 500 miles (800 kilometers) east of Cape Town. The colony had a total population of about 60,000. Nearly 20,000 were whites. The rest consisted of Khoikhoi and San, slaves, and persons of mixed ancestry.

British Rule. In 1795, France conquered The Netherlands. British troops then occupied the Cape Colony to keep it out of French hands. Britain returned the colony to the Dutch in 1803 but reoccupied it in 1806. In 1814, The Netherlands formally gave the Cape to Britain. The first British settlers arrived in 1820.

The Boers soon came to resent British colonial rule. The government made English the only official language in 1828. That same year, the Khoikhoi and Colored people received equal legal rights with whites. In 1834, Britain abolished slavery throughout its empire, which ruined a number of Boer farmers.

Many Boers decided to leave the Cape Colony to get away from British rule. Beginning in 1836, several thousand of them made a historic journey called the *Great Trek*. They loaded their belongings into ox-drawn covered wagons and headed into the interior. They defeated the Bantu-speaking peoples who tried to stop them and settled in what are now Natal, the Orange Free State, and the Transvaal. Britain annexed Natal in 1843. But it recognized the independence of the Transvaal in 1852 and the Orange Free State in 1854.

The Anglo-Boer Wars. In 1870, an incredibly rich diamond field was found where Kimberley now stands. Miners, fortune hunters, and other people from Britain and other countries flocked to the area. Both the British and the Boers claimed the Kimberley area. In 1871,

Britain annexed it. Britain annexed the Transvaal in 1877. Three years later, the Transvaal Boers rose in revolt in the First Anglo-Boer War. They defeated the British in 1881.

In 1886, the fabulous Witwatersrand gold field was discovered where Johannesburg now stands. Miners and other people rushed to the Transvaal. By 1895, these *uitlanders* (foreigners) made up about half the Transvaal's white population. To keep control of the country, the Boers restricted the political rights of the uitlanders, most of whom were British. As a result, tension grew between Britain and the Transvaal.

In 1895, Cecil Rhodes, the prime minister of the Cape Colony, plotted to overthrow the Transvaal government. He sent a force under Leander Jameson to invade the country. But the Boers captured the invaders, and the so-called Jameson Raid failed. Relations between Britain and the Transvaal then grew more strained. In 1899, the Transvaal and the Orange Free State declared war on Britain. The Boers fought bravely against huge odds before they finally surrendered in 1902. The Boer republics then became British colonies.

Meanwhile, all the African people had come under white rule. Some groups gave in without fighting. Other groups, especially the Zulu, resisted. But in 1879, the British finally defeated the Zulu kingdom. By 1898, all Africans had lost their independence.

The Union of South Africa. Britain gave colonial self-government to the Transvaal in 1906 and to the Orange Free State in 1907. The Cape Colony and Natal already had self-rule. In 1910, the four colonies formed the *Union of South Africa*, a self-governing country within the British Empire. The country's Constitution gave whites almost complete power.

During World War I (1914-1918), two Boer generals —Louis Botha and Jan Christiaan Smuts—led South African forces against Germany. Botha seized South West Africa from Germany in 1915, and Smuts defeated German East Africa in 1917. In 1920, the League of Nations gave South Africa control of South West Africa. The two Boer generals also became South Africa's first prime ministers. Botha served from 1910 to 1919, and Smuts from 1919 to 1924.

IMPORTANT DATES IN SOUTH AFRICA

c. 2000 B.C. Hunting people lived throughout much of what is now South Africa.
c. A.D. 900 Bantu-speaking farmers began to enter eastern South Africa from the north.
1488 Portuguese sailors sighted South Africa.
1652 The first Dutch settlers arrived at the present site of Cape Town.
1814 The Netherlands gave the Cape Colony to Britain.
1836 The Boers began their Great Trek from the Cape.
1852 The Transvaal became a Boer republic.
1854 The Orange Free State became a Boer republic.
1870 Diamonds were discovered in the Kimberley area.
1877 Britain annexed the Transvaal.
1879 Britain defeated the Zulu kingdom.
1880-1881 The Transvaal Boers defeated the British in the First Anglo-Boer War.
1886 The Witwatersrand gold field was discovered.
1899-1902 Britain defeated the Boers in the Second Anglo-Boer War.
1910 The Union of South Africa was formed.
1914-1918 South Africa fought Germany in World War I.
1920 The League of Nations gave South Africa control of South West Africa.
1939-1945 South Africa fought Germany in World War II.
1948 The National Party came to power.
1961 South Africa became a republic and left the Commonwealth of Nations.
1966 The United Nations voted to end South Africa's control of South West Africa.
1971 The International Court of Justice reversed an earlier decision and declared South Africa's control of South West Africa illegal.

South African Information Service, New York

The Anglo-Boer War of 1899-1902 ended in victory for Great Britain. Boer citizen-soldiers, like these men, fought bravely, but they were no match for the superior British forces.

The Rise of Afrikaner Nationalism. Botha and Smuts had fought the British in the war of 1899-1902. But as prime ministers, they tried to unite *Afrikaners* (as the Boers came to be called) and English-speaking whites. Many Afrikaner authors and churchmen, however, encouraged their people to believe they were a nation to themselves. They said Afrikaners had a heroic history, a rich culture, and a God-given mission to rule South Africa. In 1913, J. B. M. Hertzog, another Boer general who had fought the British, founded the National, or Nationalist, Party to promote these ideas.

In 1924, the National Party and the Labour Party joined forces and won control of the government. Hertzog became prime minister. During the next 15 years, he achieved many Afrikaner goals. Afrikaans became an official language in addition to English. Laws were passed protecting white workers from competition by Africans. New industries were developed to reduce South Africa's dependence on British imports. In 1931, Britain gave South Africa full independence as a member of the Commonwealth of Nations.

Afrikaner nationalism suffered a setback at the start of World War II (1939-1945). Hertzog wanted South Africa to be neutral. But Smuts wanted the country to join Britain against Germany. Smuts won the bitter debate in Parliament and became prime minister again in 1939. During the war, South Africans fought in Ethiopia, northern Africa, and Europe. In 1946, the United Nations (UN) rejected South Africa's request to annex South West Africa.

During the war, D. F. Malan, a strong supporter of Afrikaner nationalism, built up a new National Party. It came to power, under Malan, in 1948 and is still in power. The Nationalists began today's apartheid program. In 1949, the Prohibition of Mixed Marriages Act made marriages between whites and nonwhites illegal. In 1950, the Group Areas Act provided for separate white and nonwhite residential areas. Other laws gave the government far-reaching police powers.

Opposition to Apartheid. The government had long faced opposition to its racial policies. But opposition grew after the Nationalists came to power. A main opposition group was the African National Congress (ANC). Africans founded the ANC in 1912 to seek equality. But the group had no success. In the 1950's, the ANC joined with other nonwhite groups and white liberals to force reforms through boycotts, demonstrations, and strikes. The government crushed each campaign, and the movement failed. In addition, ANC members disagreed on methods and goals. In 1959, a dissatisfied group formed the Pan-African Congress (PAC).

The first PAC target was the laws that require Africans to carry *passes* (identity papers). PAC leaders told Africans to appear on March 21, 1960, at police stations without their passes—and so invite arrest. In most places, the police broke up the crowds without incident. But at Sharpeville, near Johannesburg, the police opened fire and killed 69 Africans. The government then banned the ANC and the PAC.

Opposition to apartheid also came from many countries. The government especially resented criticism from Britain and other members of the Commonwealth of Nations. On May 31, 1961, South Africa became a republic and left the Commonwealth. The UN frequently condemned South Africa's racial policies. In 1966, it voted to end the country's control over South West Africa. South Africa called the UN action illegal.

In spite of all opposition, the government held to its policies. Since 1958, the government had been headed by Prime Minister Hendrik F. Verwoerd, a man rigidly determined to carry out apartheid. In 1966, a messenger killed Verwoerd as he addressed Parliament. The assassin was insane and apparently had no political motive. Balthazar J. Vorster succeeded Verwoerd.

South Africa Today. In the early 1970's, the government continued to resist all pressures from inside and outside the country to end its racial policies. It also continued to refuse to give up South West Africa. In 1971, the International Court of Justice declared South Africa's control over the territory illegal. South Africa rejected the ruling. During the 1970's, the National Party remained firmly in power. In 1974, it won re-election for the sixth time since 1948.

LEONARD M. THOMPSON

SOUTH AFRICA / *Study Aids*

Related Articles in WORLD BOOK include:

BIOGRAPHIES

Barnard, Christiaan N.
Botha, Louis
Broom, Robert
Jameson, Sir Leander S.
Kruger, Paulus
Luthuli, Albert J.
Pretorius (family)
Rhodes, Cecil J.
Roberts, Frederick
Smuts, Jan Christiaan
Theiler, Max
Vorster, Balthazar J.

CITIES

Bloemfontein
Cape Town
Durban
Germiston
Johannesburg
Kimberley
Mafeking
Pietermaritzburg
Port Elizabeth
Pretoria
Springs

PROVINCES

Cape of Good Hope
Natal
Orange Free State
Transvaal

PRODUCTS AND INDUSTRY

For South Africa's rank in production, see:
Corn
Fishing Industry
Gold
Manganese
Mining
Platinum
Sheep
Uranium

OTHER RELATED ARTICLES

Africa
Afrikaans
Apartheid
Bantu
Boer
Boer War
Bushmen
Clothing (pictures)
Hottentot
Lesotho
Limpopo River
Orange River
South West Africa
Vaal River
Zululand

Outline

I. Government
- A. Nonwhite Governments
- B. Political Parties
- C. South West Africa
- D. Armed Forces

II. People
- A. Population and Ancestry
- B. Languages
- C. Ways of Life
- D. Food and Drink
- E. Recreation
- F. Education
- G. Religion
- H. The Arts

III. The Land and Climate
- A. Land Regions
- B. Rivers
- C. Climate

IV. Economy
- A. Natural Resources
- B. Manufacturing
- C. Mining
- D. Agriculture
- E. Labor Force
- F. Trade
- G. Transportation
- H. Communication

V. History

Questions

What are some reasons for South Africa's spectacular industrial growth?

Into what four racial groups does the government classify the people of South Africa?

What is *apartheid?*

What are the official languages of South Africa?

How does South Africa rank economically among the countries of Africa?

What political party has controlled the South African government since 1948?

How does the way of life differ among South Africa's racial groups?

Who were the first Europeans to settle in South Africa?

How important has gold been to South Africa's economic growth?

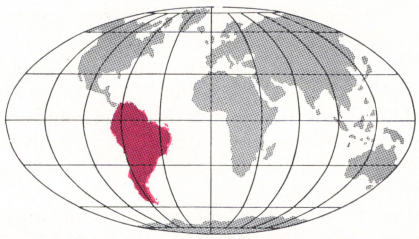
What was the *Great Trek?*

SOUTH ALABAMA, UNIVERSITY OF. See UNIVERSITIES AND COLLEGES (table).

SOUTH AMERICA

SOUTH AMERICA, the fourth largest continent, is about twice as large as the United States, but it has only about as many people. Almost half of South America is a wilderness made up of high mountains, empty plains, and tropical forests. Most of the continent's large modern cities are near the coasts.

The continent has some of the world's largest deposits of minerals, rich farmlands, and vast timberlands. However, most South American countries have been slow in developing their natural resources. Millions of South Americans live much as their ancestors did hundreds of years ago. But development projects in parts of South America have led to rapid modernization since the mid-1900's.



Preston E. James, the contributor of this article, is Maxwell Professor of Geography Emeritus at Syracuse University, and the author of Latin America.

Machu Picchu, an Ancient Inca City in Peru

Three Lions

FACTS IN BRIEF

Area: 6,884,000 sq. mi. (17,829,000 km²). *Greatest Distances*—north-south, 4,750 mi. (7,644 km); east-west, 3,200 mi. (5,150 km). *Coastline*—24,783 mi. (39,884 km).

Population: *Estimated 1976 Population*—221,000,000; density, 31 persons per sq. mi. (12 per km²).

Elevation: *Highest*—Mount Aconcagua in Argentina, 22,834 ft. (6,960 m) above sea level. *Lowest*—Península Valdés in Argentina, 131 ft. (40 m) below sea level.

Physical Features: *Chief Mountain Ranges*—Andes, Brazilian Highlands, Guiana Highlands. *Chief Rivers*—Amazon, Madeira, Magdalena, Orinoco, Paraguay, Paraná, Pilcomayo, Purús, São Francisco, Uruguay. *Chief Lakes*—Maracaibo, Mirim, Poopó, Titicaca. *Chief Islands*—Falkland Islands, Galapagos Islands, Marajó, Tierra del Fuego. *Chief Gulfs*—Darien, Guayaquil, San Jorge, San Matiás, Venezuela. *Largest Deserts*—Atacama, Patagonia. *Largest Waterfalls*—Angel, Kukenaam.

Chief Products: *Agriculture*—bananas, beef, cacao, coffee, corn, cotton, sugar cane, wheat, wool. *Manufacturing and Processing*—automobiles, beverages, canned meats, cement, chemicals, electrical appliances, flour, packaged foods, paper, textiles. *Mining*—bauxite, copper, emeralds, gold, iron ore, lead, manganese, nitrate, petroleum, silver, tin, tungsten, zinc.

Christ of the Andes, on the Argentina-Chile Border J. Barnell, Shostal

About 40 per cent of the people of South America work on farms, plantations, and ranches. But most of the small farmers cannot raise enough food to feed their families from their small plots of poor land. A relatively few wealthy families own huge areas of fertile land that lies idle. How to put this idle land to use is probably South America's greatest problem. The governments of most South American countries have started or are planning land reform programs. Under these programs, some large estates are being broken up, and the land is given to small farmers.

Manufacturing is growing rapidly in South America. But South American countries still must import many manufactured products. They pay for these goods by exporting agricultural products and minerals. South America exports such agricultural products as bananas, beef, coffee, cotton, sugar, wheat, and wool. The chief mineral exports of South America are bauxite, copper, iron ore, manganese, petroleum, silver, and tin.

Brazil, the largest of the 11 independent South American countries, covers almost half the continent. The other countries in order of size are Argentina, Peru, Colombia, Bolivia, Venezuela, Chile, Paraguay, Ecuador, Guyana, and Uruguay. Two small possessions of European countries occupy the northeastern edge of South America. They are Surinam, an overseas territory of The Netherlands, and French Guiana, an overseas department of France. The Falkland Islands, a British colony, lie in the South Atlantic Ocean, about 300 miles (480 kilometers) southeast of the tip of the South American continent.

South America is part of the cultural region called *Latin America* that also includes Mexico, Central America, and the islands of the Caribbean Sea. For information on the way of life of the people and their education, arts, and history, see LATIN AMERICA.

INDEPENDENT COUNTRIES OF SOUTH AMERICA

Map Key	Name	Area In sq. mi.	Area In km²	Population	Capital	Government	Date of Independence
L-5	**Argentina**	1,072,163	2,776,889	25,391,000	Buenos Aires	Republic	1816
I-5	**Bolivia**	424,165	1,098,581	5,756,000	La Paz; Sucre	Republic	1825
H-7	**Brazil**	3,286,488	8,511,965	110,829,000	Brasília	Republic	1822
K-4	**Chile**	292,258	756,945	9,639,000	Santiago	Republic	1818
F-4	**Colombia**	439,737	1,138,914	25,511,000	Bogotá	Republic	1819
G-3	**Ecuador**	109,484	283,561	7,439,000	Quito	Republic	1830
E-6	**Guyana**	83,000	214,969	826,000	Georgetown	Republic	1966
J-6	**Paraguay**	157,048	406,752	2,950,000	Asunción	Republic	1811
H-4	**Peru**	496,225	1,285,216	16,334,000	Lima	Republic	1821
L-7	**Uruguay**	68,536	177,508	3,100,000	Montevideo	Republic	1828
E-5	**Venezuela**	352,145	912,050	12,539,000	Caracas	Republic	1830

OTHER POLITICAL UNITS IN SOUTH AMERICA

Map Key	Name	Area In sq. mi.	Area In km²	Population	Status
O-6	**Falkland Islands**	4,618	11,961	2,045	British colony
F-7	**French Guiana**	35,135	91,000	67,000	Overseas department of France
E-7	**Surinam (Dutch Guiana)**	63,037	163,265	473,000	Overseas territory of The Netherlands

Each country and political unit has a separate article in WORLD BOOK.

Populations are 1976 estimates based on the latest figures from official government and United Nations sources.

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UNITED STATES
Houston
New Orleans
Miami
Gulf of Mexico
BERMUDA (G.B.)
North
North Atlantic Ocean
BAHAMAS
Nassau
Havana
CUBA
Tropic of Cancer
TURKS AND CAICOS ISLANDS (G.B.)
Mérida
20° North Latitude
CAYMAN ISLANDS (G.B.)
Santiago de Cuba
JAMAICA
Kingston
HAITI
Port-au-Prince
DOMINICAN REPUBLIC
Santo Domingo
PUERTO RICO (U.S.)
San Juan
VIRGIN ISLANDS (U.S. and G.B.)
ANGUILLA (G.B.)
BARBUDA (G.B.)
ANTIGUA (G.B.)
ST. CHRISTOPHER (G.B.)
NEVIS (G.B.)
MONTSERRAT (G.B.)
GUADELOUPE (Fr.)
DOMINICA (G.B.)
MARTINIQUE (Fr.)
MEXICO
Belmopan
BELIZE (G.B.)
Caribbean Sea
WEST INDIES
GUATEMALA
Guatemala City
HONDURAS
Tegucigalpa
San Salvador
EL SALVADOR
NICARAGUA
Managua
NETHERLANDS ANTILLES (Neth.)
ST. LUCIA (G.B.)
ST. VINCENT (G.B.)
BARBADOS
GRENADA
TRINIDAD AND TOBAGO
Port-of-Spain
Barranquilla
Cartagena
Maracaibo
Cabimas
Maracay
Maiquetía
Caracas
Lake Maracaibo
Barquisimeto
Valencia
VENEZUELA
San José
COSTA RICA
PANAMA CANAL ZONE (U.S.)
Panama City
PANAMA
Cúcuta
San Cristóbal
Orinoco River
Ciudad Bolívar
Santo Tomé de Guyana
Georgetown
Paramaribo
Cayenne
Cauca
Medellín
Bucaramanga
Magdalena River
Angel Falls
Kukenaam Falls
GUYANA
SURINAM (Neth.)
FRENCH GUIANA (Fr.)
Manizales
Pereira
Bogotá
North Pacific Ocean
Cali
COLOMBIA
ANDES MOUNTAINS
Quito
Ambato
ECUADOR
Guayaquil
Cuenca
Negro River
Amazon River
Manaus
Santarem
MARAJÓ ISLAND
Belém
São Luís
0° Equator
GALAPAGOS ISLANDS (Ecuador)
Iquitos
Amazon
Marañón River
Ucayali River
Madeira River
Xingu River
Tocantins River
Fortaleza
Teresina
FERNANDO DE NORONHA (Brazil)
Natal
João Pessoa
Recife
Maceió
São Francisco River
Paulo Afonso Falls
Chiclayo
Trujillo
Chimbote
HUASCARÁN
▲ 22,205 ft.
(6,768 m)
PERU
Lima
Callao
MACHU PICCHU
Guaporé River
BRAZIL
SOUTH AMERICA
Political Map
Capital
Other City or Town
MOUNTAIN
River
Abbreviations on Map
(Fr.) . . . . . France
(G.B.) . . . . Great Britain
(Neth.) . . . . Netherlands
(U.S.) . . . . . United States
WORLD BOOK map Azimuthal Equal-Area Projection
The area of South America is about two times larger than the area of the United States, excluding Alaska and Hawaii.
NORTH AMERICA
Equator
AFRICA
SOUTH AMERICA
ANTARCTICA

Cusco
ILLAMPU
21,490 ft.
(6,550 m)
Lake Titicaca
Arequipa
La Paz
Cochabamba
Oruro
BOLIVIA
San José
Arica
Sucre
Lake
Poopó
ANDES MOUNTAINS
Mamoré
Paraguay River
Salvador
Brasília
Goiânia
Belo Horizonte
Paraná River
Duque de Caxias
Campos
São Gonçalo
Nova Iguaçu
Niterói
Campinas
Londrina
São Paulo
Santo André
Rio de Janeiro
Santos
TRINDADE ISLAND (Brazil)
20° South Latitude
Antofagasta
PARAGUAY
Pilcomayo River
Asunción
Iguaçu Falls
Curitiba
Iguaçu
Tucumán
OJOS DEL SALADO
22,590 ft. (6,885 m)
PISSIS
22,546 ft.
(6,872 m)
Tropic of Capricorn
SAN FÉLIX ISLAND (Chile)
SAN AMBROSIO ISLAND (Chile)
Salado River
Uruguay River
CHILE
Pôrto Alegre
MERCEDARIO
22,211 ft.
(6,770 m)
Córdoba
Santa Fe
Rivera
Salto
Paysandú
Pelotas
ACONCAGUA
22,831 ft. (6,961 m)
(Highest point in Western Hemisphere)
Mendoza
Rosario
South Pacific Ocean
South Atlantic Ocean
Viña del Mar
Valparaíso
CHRIST OF THE ANDES
URUGUAY
JUAN FERNÁNDEZ ISLANDS (Chile)
Santiago
TUPUNGATO
22,310 ft.
(6,800 m)
Buenos Aires
Montevideo
ARGENTINA
Lanús
La Plata
Río de la Plata
Talcahuano
Concepción
Huachipato
Salado
Mar del Plata
Bahía Blanca
Colorado River
Bahía Blanca
Golfo San Matías
North
40° South Latitude
Golfo San Jorge
FALKLAND ISLANDS (G.B.)
Stanley
Strait
of Magellan
Punta Arenas
TIERRA DEL FUEGO ISLAND
Ushuaia
CAPE HORN
SOUTH GEORGIA ISLAND (Falkland Islands)
100° West Longitude
80° West Longitude
60° West Longitude
40° West Longitude
20° West Longitude
I
J
K
L
M
N
O
1
2
3
4
5
6
7
8
9
10
11
Distance Scale
0 Miles 500 1,000 1,500 2,000 2,500 3,000 3,500 4,000 4,500
0 Kilometers 500 1,000 1,500 2,000 2,500 3,000 3,500 4,000 4,500 5,000 5,500 6,000 6,500 7,000

SOUTH AMERICA/*Land Regions*

The equator crosses South America near the continent's widest point. More than three-fourths of South America lies in the tropics. From the equator southward, the continent narrows sharply. Its southern tip is only about 600 miles (970 kilometers) from Antarctica.

Oceans surround South America except at its northwest corner, where the narrow Isthmus of Panama links the continent to North America. The Pacific Ocean washes South America's western shores, and the Atlantic Ocean borders the continent on the east. The Caribbean Sea is on the north. The Drake Passage separates South America from Antarctica.

The land surface of South America is much like that of North America. High mountains tower in the west, and low mountains form highlands in the east. Great plains cover most of the central area. South America has four main land regions: (1) the Pacific Coastlands, (2) the Andes Mountains, (3) the Central Plains, and (4) the Eastern Highlands.

The Pacific Coastlands lie along the Pacific Ocean, west of the Andes Mountains. Most of the coastlands are less than 50 miles (80 kilometers) wide, and in some places they are only 5 miles (8 kilometers) wide. The northern coastlands in Colombia and Ecuador are swampy and covered by tropical forests. In Peru and northern Chile, the coastlands form a desert. In central Chile, the Pacific Coastlands are a fertile area of farms, grazing lands, and forests. Farther south, the seas flow into the valleys to form the Chilean archipelago, a 1,000-mile (1,600-kilometer) stretch of stormy fiords and cold, rainy islands.

The Andes Mountains rise along the entire western coast of South America. They form the longest mountain range in the world, and only the Himalayas in Asia are higher. Over 50 Andean peaks are higher than 20,000 feet (6,100 meters). These include 22,834-foot (6,960-meter) Mount Aconcagua in Argentina, the highest peak in the Western Hemisphere. Earthquakes often shake parts of the Andes region, and some Andean peaks are active volcanoes. Glaciers move slowly toward the sea in many valleys, especially in the south.

In most places, the Andes region is not more than 200 miles (320 kilometers) wide. It widens to about 450 miles (724 kilometers) in Bolivia, and narrows to less than 20 miles (32 kilometers) in Chile.

In addition to snow-capped peaks and rocky cliffs, the Andes region also has thickly forested slopes, grassy plateaus, and valleys. Andean valleys make up much of Colombia and Venezuela. In Bolivia, a plateau 400 miles (640 kilometers) long lies about 12,500 feet (3,810 meters) above sea level.

The Central Plains, east of the Andes Mountains, cover about three-fifths of South America. The plains consist of four large areas: (1) grassy plains called *llanos* in the Orinoco River basin of Colombia and Venezuela; (2) tropical rain forests called *selvas* in the Amazon River basin of Brazil; (3) partly forested scrublands in the Gran Chaco region that lies largely in Argentina and Paraguay; and (4) productive farmlands and ranch lands of Argentina called the *Pampa*.

The South American central plains are largely unproductive. However, the rich soil and temperate climate of the Pampa make it suitable for farming.

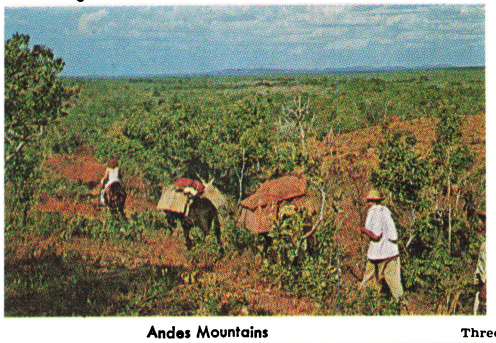
The Eastern Highlands consist of mountains that are much lower than the Andes. The highlands form three separate areas: (1) the Guiana Highlands, (2) the Brazilian Highlands, and (3) the Patagonian Plateau.

The Guiana Highlands rise along Brazil's northern boundary. They are covered mainly by tropical forests, and are less than 5,000 feet (1,500 meters) high.

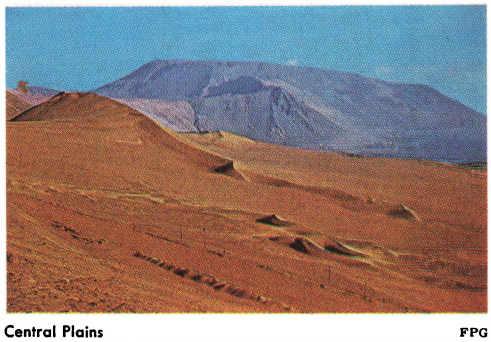
The Brazilian Highlands, largest of the three areas, cover eastern Brazil. The mountains that rise steeply along the Atlantic coast include 9,482-foot (2,890-meter) Pico da Bandeira, the highest point east of the Andes. Inland, the highlands area is generally one of tablelands and rolling hills, sloping away from the coast. Rich mines, coffee plantations, cattle ranches, and two of South America's largest industrial centers—Rio de Janeiro and São Paulo—are in this area.

The Patagonian Plateau forms flat, rocky tablelands in southern Argentina. These tablelands make up one of the world's largest sheep-grazing areas.

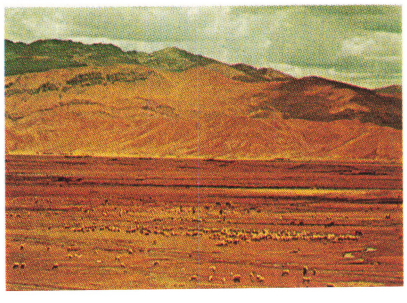
Eastern Highlands — Harald Schultz



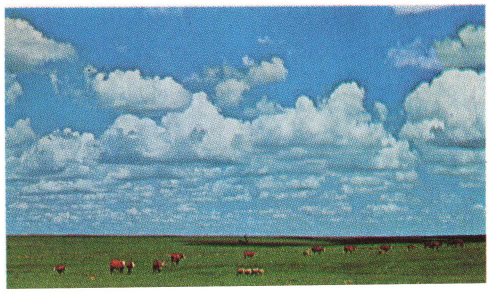
Pacific Coastlands — Leon V. Kofod



Andes Mountains — Three Lions



Central Plains — FPG



Specially created for **World Book Encyclopedia** by Rand McNally and World Book editors

Lake Titicaca — Tom Hollyman, Photo Researchers

SOUTH AMERICA/ *Natural Features*

Rivers. Five great river systems drain the South American continent: (1) the Amazon; (2) the Río de la Plata system, formed by the Paraná, Paraguay, and Uruguay rivers; (3) the Magdalena-Cauca; (4) the Orinoco; and (5) the São Francisco.

The Amazon drains an area of about 2,400,000 square miles (6,220,000 square kilometers), the largest drainage basin in the world. It rises in the Peruvian Andes and flows 3,900 miles (6,280 kilometers) into the Atlantic Ocean. Only the Nile River is longer.

The Río de la Plata system forms the most important inland waterway system in Latin America. It serves Argentina, Bolivia, Brazil, Paraguay, and Uruguay.

The Magdalena and Cauca rivers flow through two long Andean valleys in Colombia. They join, and empty into the Caribbean Sea.

The Orinoco flows along the Colombia-Venezuela border and through the middle of Venezuela to the Atlantic Ocean. More than 400 tributaries give the Orinoco a huge volume of water.

The São Francisco, which is 1,988 miles (3,199 kilometers) long, drains the eastern Brazilian highlands.

Waterfalls. South America's many waterfalls include two of the world's highest. One, Angel Falls, on one of the headwaters of the Caroní River in southeastern Venezuela, drops 3,212 feet (979 meters). Kukenaam Falls in Venezuela falls about 2,000 feet (610 meters). Brazil's many smaller falls include Paulo Afonso Falls on the São Francisco River and Iguaçu Falls on the Brazil-Argentina border. See BRAZIL (picture).

Ushuaia, Tierra del Fuego — Harrison Forman

Upper Amazon River — Shostal

Lakes. South America has few large lakes. The largest is Lake Maracaibo, which covers 6,300 square miles (16,300 square kilometers) in Venezuela. Lake Titicaca on the Bolivia-Peru border is the highest body of water in the world on which steamships operate. It lies in the Andes, 12,507 feet (3,812 meters) above sea level, and covers 3,261 square miles (8,446 square kilometers).

Islands. Several major island groups lie off the coasts of South America. The largest is the Tierra del Fuego group. It is separated from the southern end of the mainland by the stormy Strait of Magellan. Argentina and Chile own these islands. Chile also owns the Juan Fernández Islands, about 400 miles (640 kilometers) west of the mainland in the Pacific Ocean. The Falkland Islands, about 300 miles (480 kilometers) east of the Strait of Magellan in the Atlantic Ocean, are a British crown colony. Both Tierra del Fuego and the Falklands have valuable sheep-grazing lands. The Galapagos Islands are South America's principal islands in the Pacific Ocean. They lie about 600 miles (960 kilometers) off Ecuador, which owns them. The Galapagos Islands, once a pirate hideout, have large colonies of lizards, huge turtles, and birds. Marajó, a flat, grassy island, lies at the mouth of the Amazon River. It is owned by Brazil.

Angel Falls — Ewing Krainin, Photo Researchers

SOUTH AMERICA/*Climate*

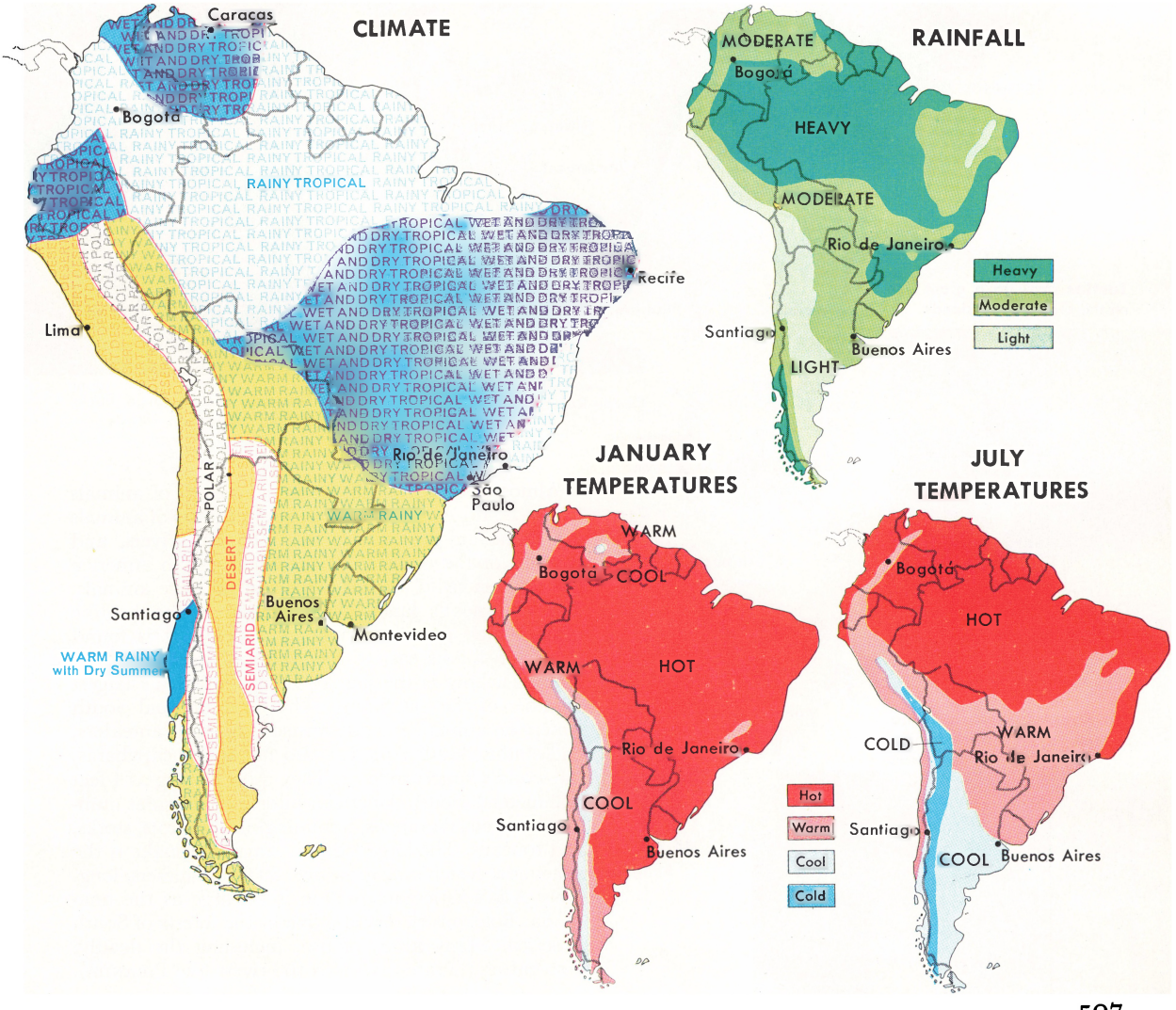
Most of South America is warm the year around, except high in the Andes Mountains where the climate is always cold. The lowland area in the widest part of the continent, near the equator, is always hot and humid. The narrow southern part of the continent has cool summers and mild winters. Both the summers and winters are much milder than those of most of North America. The seasons south of the equator are opposite to those of North America—summers last from December to March, and winters are from June to September.

Although South America's climate is warm, temperatures usually do not rise as high as summer temperatures in North America. Even in the tropical lowlands of the Amazon River valley, the temperature generally ranges from 70° to 90° F. (21° to 32° C), and rarely reaches 100° F. (38° C). The hottest weather occurs in the Argentine Gran Chaco. The temperature there climbs above 110° F. (43° C) at least once a year.

South America has four regions where rainfall averages more than 60 inches (150 centimeters) a year: (1) the Amazon River valley, (2) the coastal lands of Guyana, French Guiana, and Surinam, (3) the coasts of Colombia and Ecuador, and (4) southwestern Chile.

Rain-bearing winds sweep into South America from both the Atlantic and the Pacific oceans. East of the Andes Mountains, the Atlantic trade winds bring rains to the northern two-thirds of the continent (see Trade Wind). West of the Andes, in the north, heavy rains drench the coast of Colombia. In the south, the Pacific's moist westerlies keep Chile's central valley well watered in winter. They bring heavy rain to the Chilean archipelago during most of the year.

The cold Peru Current of the Pacific Ocean flows near the continent's southwest coast. It cools the air that blows onto shore at a low level. This cooling of the lower air prevents rain from forming. As a result, the coastal lands in Peru and northern Chile are dry. Cold Atlantic Ocean currents act the same way on the breezes that blow over southeastern South America. As a result the Patagonian Plateau gets little rainfall.



SOUTH AMERICA / *Animals*

Ron Church

Fierce Little Piranhas of the Amazon River attack humans and eat their flesh.

Cy La Tour

Toucans nest in large flocks in South American forests.

Turtles grow to a giant size on the Galapagos Islands.

Cy La Tour, courtesy of San Diego Zoological Garden

The South American Llama belongs to the camel family.

Cy La Tour

Almost a fourth of all the known kinds of animals live in South America. The largest numbers of animals are found in the rain forests, plateaus, rivers, and swamps of the Amazon River basin. South America has no great wild animal herds and no huge animals. The continent's largest wild animal is the hoglike tapir, which grows as large as a pony. It is found chiefly in forests east of the Andes. The tapir's chief natural enemy is the jaguar, South America's largest member of the cat family. The most unusual South American animals include armadillos, giant anteaters, and sloths. South America also has many capybaras, the world's largest rodents. They grow as long as 4 feet (1.2 meters). South American birds include great numbers of egrets, flamingos, hummingbirds, parrots, storks, and toucans. The largest South American snake is the anaconda, which may grow over 30 feet (9 meters) long. Only Asia's reticulate python is as large as the anaconda. Boa constrictors also live in the forests of South America. Many kinds of fish, including the deadly, flesh-eating piranha, swim in the rivers (see PIRANHA).

SOUTH AMERICA/*Plants*

Harald Schultz

Orchids of rare beauty grow wild in the South American rain forests.

Cattleya Orchid
Logwood
Crabwood
Cigar-Box Cedar
Kapok
Cannon-Ball Tree
Assai Palm
Greenheart
Carnauba Palm
Rosewood
Brazil Nut
Ivory Palm
Portulaca
Panama Hat Palm
Cacao
Rubber Tree
Calabash Tree
Tree Fern
Bamboo
Balsa
Cassava
Cotton
Coca
Coconut Palm
Pineapple
Cinchona
Avocado
Arrowroot
Giant Bromelia
Cashew
Philodendron
Mahogany
Jacaranda
Paraná Pine
Maté
Quebracho
Paper-Spine Cactus

Harald Schultz

Brazil-nut Trees grow to 150 feet (46 meters) in height.

Tall Tree Ferns are common in the tropical mountain areas.
Harald Schultz

Illustrated by Richard Kaneiss for WORLD BOOK

Some kinds of plants that grow in South America cannot be found on any other continent. More than 2,500 kinds of trees grow in the rain forests, and so many varieties of orchids bloom there that they have never been fully counted. The carnauba palm provides valuable lubricating and polishing waxes. The quebracho tree supplies one of the hardest of all woods, a chief source of tannin, used to tan hides and to make inks and dyes. The bark of the cinchona tree is the chief natural source of quinine, a drug used to treat malaria. Many rubber trees grow wild, and South American Indians were the first to discover the use of rubber. The giant among South American plants is the Brazil-nut tree in the Amazon River forests. It grows up to 150 feet (46 meters) tall. Balsa, one of the lightest woods, grows on the northwest coast, mainly in Ecuador. Other important South American trees include mahogany, pine, and rosewood.

SOUTH AMERICA/ *Agriculture*

About 40 per cent of the people of South America earn their living on farms or ranches. The average South American farm is small, and barely provides a living for the farm family. Most farms produce simple food crops such as beans, cassava, and corn. Most South American farmers still plow the land with ox-drawn plows and plant seeds by hand. These farmers reap small harvests. As a result, food shortages occur frequently.

South America also has some of the world's largest farms, plantations, and ranches. They are owned by wealthy families, and produce such important exports as bananas, beef, coffee, sugar, wheat, and wool. Sharecroppers and hired laborers do the work. The owners let much good farmland lie idle as meadows or as pastures for their riding horses. The largest farms and ranches spread over the plains, plateaus, and valleys of Argentina and Brazil. On the broad Pampa in central Argentina, cattle graze on many ranches larger than 100,000 acres (40,000 hectares) each. In southern Argentina's Patagonia region, some sheep ranches cover over 1,000,000 acres (400,000 hectares). Brazil has some plantations as large as the state of Oregon.

In most South American countries, government programs have been started to break up large estates into small farms. These land reform programs aim to put much idle land to use and increase food production. However, the landowners must be paid for the land, and the new owners need money to buy seed, fertilizer, and modern machinery. The governments do not have enough money to pay for large-scale land reform programs. The United States has made loans to assist land reform programs in such countries as Argentina, Brazil, Chile, and Venezuela.

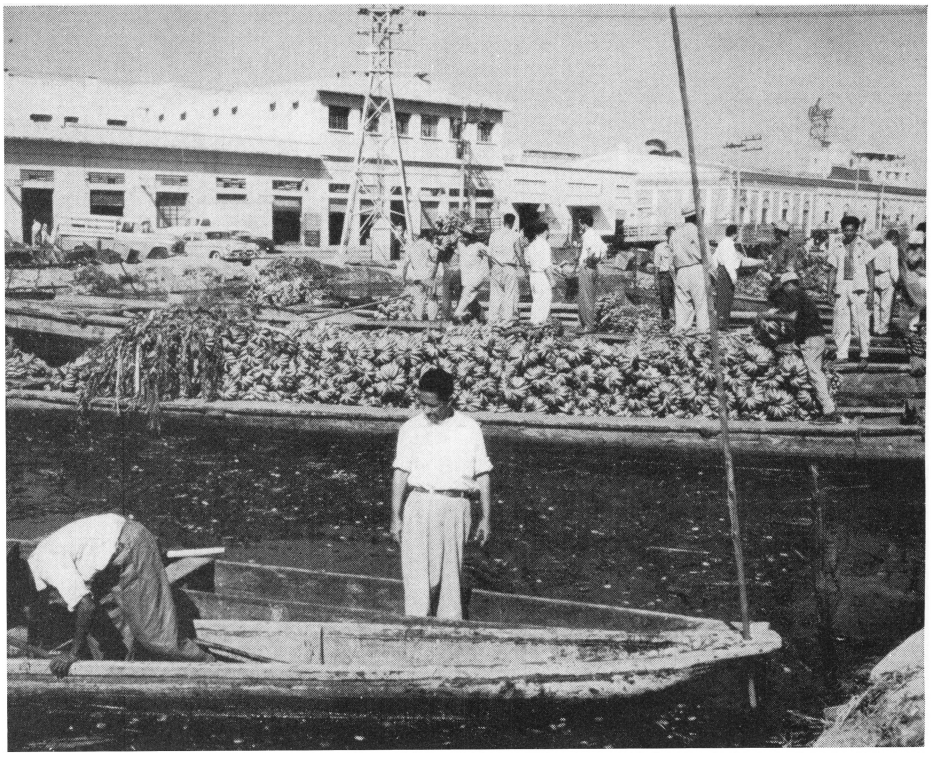
A major problem of South America is to find ways of increasing food production to meet the needs of growing populations. Some countries, such as Brazil and Venezuela, operate model farms. These farms show farmers how modern methods can be used to raise larger crops.

B. Newman, Photo Researchers

Sheep Raising is a major agricultural industry of South America. Some Argentine ranches in the vast sheep raising region of Patagonia cover 1,000,000 acres (40,000 hectares). The Peruvian Indians graze their small flocks on grassy slopes high in the Andes Mountains.

Bananas rank among the chief agricultural products of South America. Ecuador exports more bananas than any other country in the world, and Brazil and Colombia are also leading banana exporters. Many of Colombia's bananas are carried in small boats from the plantations to the port of Barranquilla for shipment abroad.

Robert Leahy, Shostal



Three Lions

Modern Machinery and ancient oxcarts often work side by side on the large farms that produce grains for the world market.

Joe Barnell, Shostal

Growing Coffee requires much hand labor. These plantation workers are cultivating trees in the state of São Paulo, Brazil, one of the world's chief coffee-producing areas.

South American Cattle are raised on ranches that cover some of the largest grazing lands in the world. Chilled beef is a major export of Argentina and Uruguay.

Authenticated News Int.

SOUTH AMERICA / *Mining*

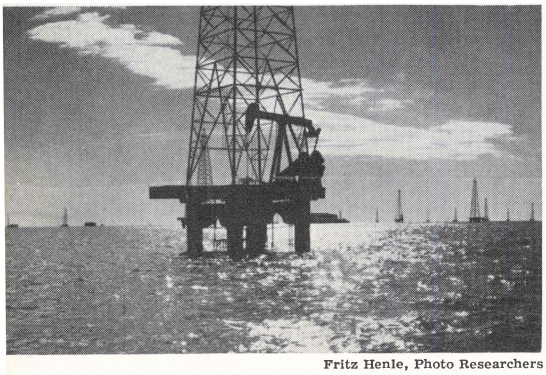
South America has some of the world's largest deposits of minerals. These minerals have made possible the development of important manufacturing industries in Brazil, Chile, Colombia, Peru, Uruguay, and Venezuela. Argentina has relatively few minerals except for petroleum. The large Argentine manufacturing industry is built chiefly around factories that process farm and ranch products. Much of South America's mineral wealth remains untouched in mountainous and tropical regions that are hard to reach. However, mining is the most important industry of Bolivia, Chile, and Venezuela. These countries earn most of their income by selling minerals on the world market.

Petroleum is South America's most valuable export. Most of the petroleum that is exported comes from Venezuela, one of the world's leading petroleum-producing countries. Colombia, Ecuador, and Peru also export some petroleum.

Chile is the world's largest copper-exporting country, and ranks as a leader in total copper production. Chile also exports much iron ore and nitrate. It has the world's only deposits of natural sodium nitrate, used largely for fertilizer.

Some of the world's largest iron ore deposits are in Brazil and Venezuela. Brazilian mines also produce large amounts of bauxite and manganese. Bolivia ranks among the world's leading suppliers of tin, and also exports lead, silver, tungsten, and zinc. Peru is a leading silver producer. Colombia is the largest producer of emeralds in the world. Large bauxite deposits are mined in Surinam and Guyana.

South America, like Africa and Australia, has only small deposits of coal. The only country on the continent in which coal is a chief mining product is Colombia, though Brazil, Chile, and Peru mine some coal. Most South American countries import coal to power many of their manufacturing industries. To make up for their small supplies of coal, the larger countries, such as Argentina, Brazil, and Chile, are expanding oil production. They also are building hydroelectric projects.



Fritz Henle, Photo Researchers

Petroleum is South America's most valuable export, and Venezuela produces almost all of it. Many oil-pumping derricks operate in Lake Maracaibo.

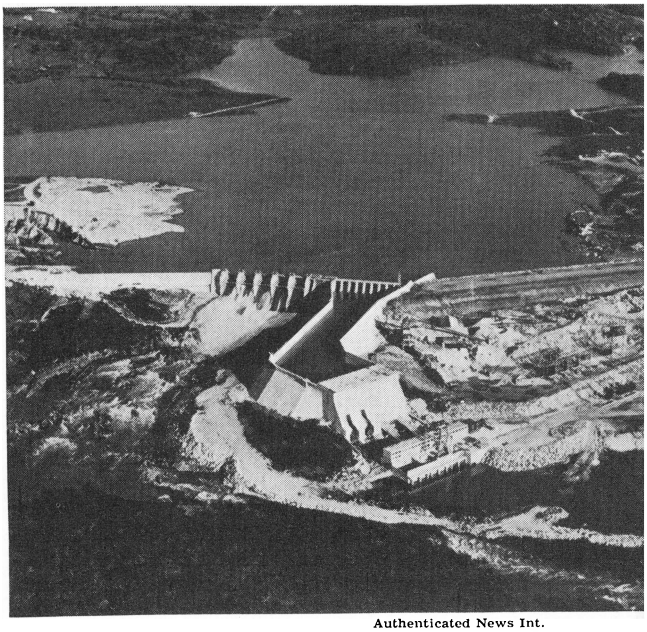
Mining helps support several South American countries. Bolivia supplies the world market with many minerals, such as tin from this mine at San José.

Thorlichen, Black Star

SOUTH AMERICA/ *Manufacturing*

Manufacturing has become an important industry in South America, largely since the 1920's. Its most rapid growth came after World War II. When the war ended, the demand for South America's farm and mine exports fell sharply. The governments of several South American countries, especially Argentina, Brazil, and Chile, helped businessmen start factories to make use of locally produced raw materials. Large American and European companies also were invited to open manufacturing branches in South America. As a result, hundreds of factories now operate, and manufacturing centers have been built in several countries. South America's chief manufactured products are textiles and processed foods, such as canned meats, flour, and refined sugar. However, the output also includes many products which previously were imported from Europe or the United States. Among these products are automobiles, cement, chemicals, drugs, electrical appliances, furniture, glassware, machinery, and paper.

Most South American countries aim to build self-supporting economic systems by further expansion of their manufacturing industries. All the South American countries have large resources of manpower. They are handicapped by a lack of the large amounts of money needed for such development. However, the United States and other countries are assisting South America's economic development, largely through long-range programs of international development agencies.



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Hydroelectric Dams supply industrial power in several South American countries that lack large supplies of coal or oil. The Itulinga Dam generates electricity near Rio de Janeiro.

Manufacturing has grown rapidly in many South American countries since the end of World War II. Textiles and processed foods make up the chief products of the factories. Chile's Huachipato steel mill is one of the giants of South American heavy industry.

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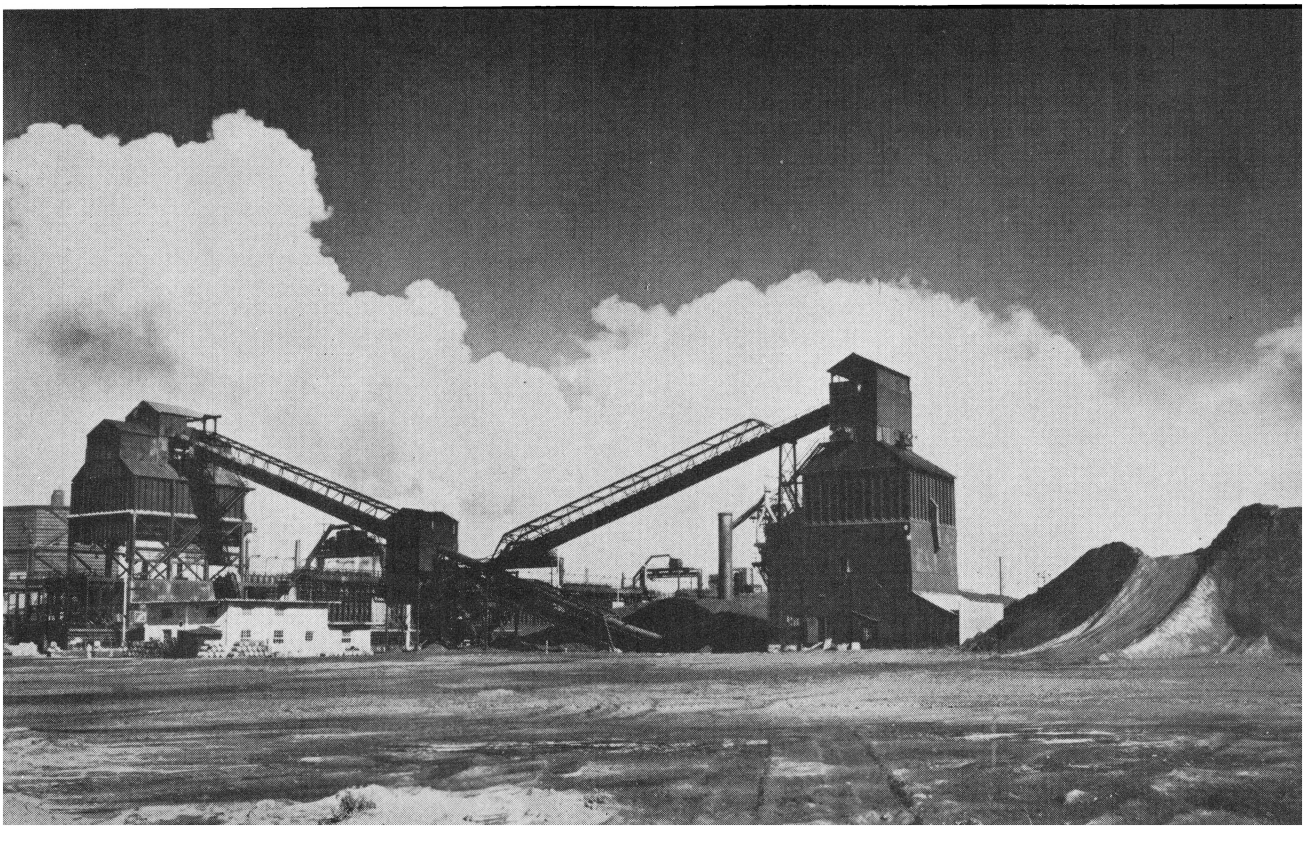


SOUTH AMERICA/*Transportation and Communication*

Both airplanes and oxcarts are common means of transportation in South America. Railroads and good highways serve the large cities. But in most country areas, horses and oxen pull high-wheeled carts over dirt roads. Millions of South Americans who live in those areas have never ridden in an automobile or even seen a railroad train. Most South Americans have to travel on foot and carry heavy burdens on their backs. Vast forest regions of the continent have no roads at all. In regions with rivers, small boats carry people and goods between the villages. Elsewhere, especially in mountainous areas, pack animals, such as mules or llamas, are used for travel on the rugged trails.

The development of commercial aviation has greatly improved long-distance travel in South America. The airplane solved the problem of crossing high mountains and tropical rain forests that made railroad construction difficult. More than 50 international airlines and many domestic airlines crisscross the continent.

Most of South America's railroads are in Argentina and southeastern Brazil, where many people live. Argentina, with about 25,000 miles (40,200 kilometers) of railroads, and Brazil, with about 20,000 miles (32,000 kilometers) of railroads, rank among the 10 countries of the world with the greatest railroad mileage. Chile, Colombia, and Uruguay have railroads that connect their important cities. However, much of the equipment on South America's railroads is old and worn, and service on some lines is poor.

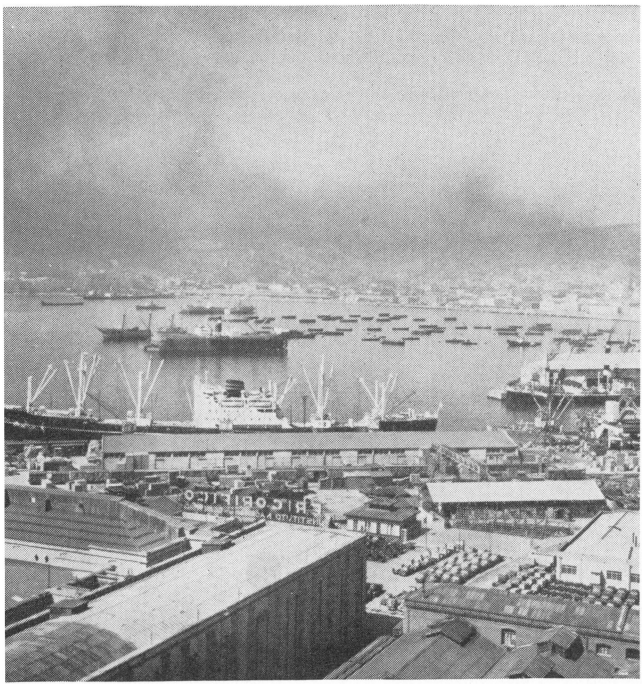
Many South American countries are building new highways to keep pace with their growing automobile and truck manufacturing industries. The continent has about 500,000 miles (800,000 kilometers) of roads. Only about 30,000 miles (48,000 kilometers) of these roads are paved, compared with more than 2 million miles (3.2 million kilometers) of paved highways in the United States. The Pan American Highway links the countries of South America (see PAN AMERICAN HIGHWAY).

Steamships provide the most important means of commerce between South American countries and the rest of the world. The largest merchant fleets belong to Brazil, which has about 420 ships, and Argentina, with about 335 ships. Chile also has a large merchant marine, and Colombia, Ecuador, Peru, and Venezuela have many ships in coastal trade.

Communication is one of the basic problems in South America. More than half the people cannot read, and most South Americans cannot afford a telephone, radio, or television set. A majority of South Americans must depend for information on what they hear from people around them. In country areas, the town market place serves as a major communication

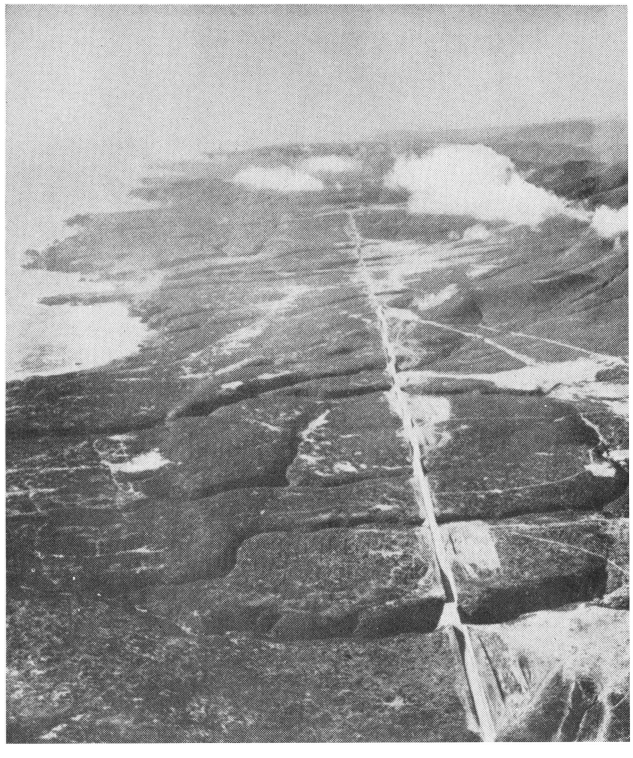
Steamships provide South American countries with their most important means of commerce. Argentina and Brazil operate South America's largest merchant fleets. Many of the continent's major cities are seaports, such as Valparaíso, Chile.

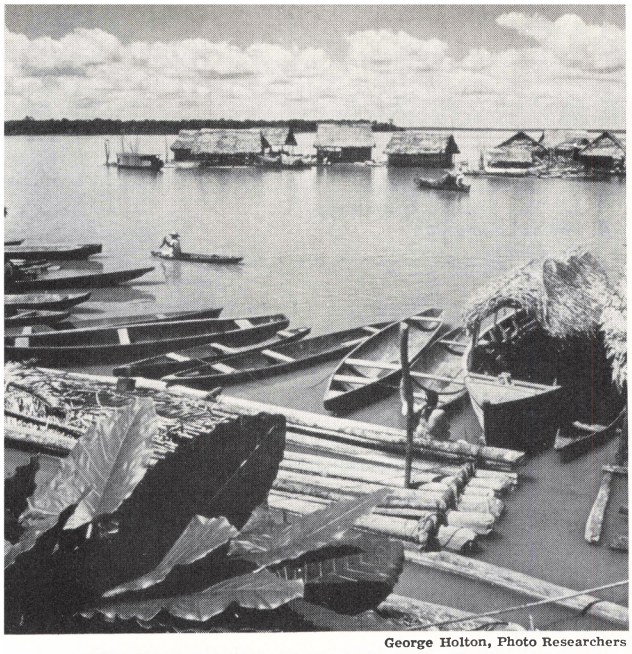
Joe Barnell, Shostal



The Pan American Highway links the countries of South America, often slicing through thick forests or swamps. This section of the highway is in Chile.

General Secretariat, OAS





George Holton, Photo Researchers

Small Boats are common means of transportation in many South American areas where rivers serve as roads. Villagers on the upper Amazon River use boats such as these Peruvian craft at Iquitos.

center. There, the people gather to talk about local happenings, and to pick up news about national and world events. In the cities, wealthy and middle class people have telephones, radios, and television sets. But even in the cities, many South Americans are too poor to own modern communication devices.

Argentina and Brazil together publish more books and magazines than all the other countries of South America combined. In most countries, the publications are in Spanish, but those in Brazil are in Portuguese. All the South American countries have radio stations, but there are only about eight radio receivers for every hundred people. Television stations broadcast in Argentina, Brazil, Chile, Colombia, Peru, Uruguay, and Venezuela. But there is only one television set for about every hundred South Americans. PRESTON E. JAMES

Authenticated News Int.

Railroads of South America often operate with old equipment. The old-fashioned trains of this Peruvian line climb over 15,000 feet (4,570 meters) to towns nestled in the Andes Mountains.

Air Transport has greatly improved long-distance travel in South America. Many airlines crisscross the continent, and all the large cities have modern airports.

Pan American World Airways

SOUTH AMERICA/*Study Aids*

Related Articles in WORLD BOOK include:

COUNTRIES

Argentina	Colombia	Peru
Bolivia	Ecuador	Uruguay
Brazil	Guyana	Venezuela
Chile	Paraguay	

COLONIES AND TERRITORIES

Falkland Islands	French Guiana	Surinam

LARGE CITIES

Belo Horizonte	Pôrto Alegre
Bogotá	Recife
Buenos Aires	Rio de Janeiro
Caracas	Salvador
Lima	Santiago
Montevideo	São Paulo

ISLANDS

Galapagos Islands	Marajó
Juan Fernández	Tierra del Fuego

MOUNTAINS

Aconcagua	Cotopaxi	Illimani
Andes Mountains	El Misti	Ojos del Salado
Chimborazo	Huascarán	Pichincha
Cordillera	Illampu	

PLAINS AND DESERTS

Atacama Desert	Pampa
Gran Chaco	Patagonia
Llanos	

PRODUCTS

Balsa	Manganese
Banana	Maté
Bauxite	Nitrate
Cacao	Petroleum
Cattle	Quebracho
Coffee	Rubber
Copper	Silver
Corn	Sugar
Cotton	Tin
Emerald	Wheat
Guano	Wool

RIVERS, LAKES, AND WATERFALLS

Amazon River	Orinoco River
Angel Falls	Paraguay River
Araguaia River	Paraná River
Iguaçu River	Purús River
King George VI Falls	Río de la Plata
Kukenaam Falls	Rio Negro
Lake Maracaibo	Roraima Falls
Lake Titicaca	São Francisco, Rio
Madeira River	Tapajós River
Magdalena River	Tocantins River
Marina Fall	Uruguay River

OTHER RELATED ARTICLES

Alliance for Progress	Magellan, Strait of
Cape Horn	Pan-American Conferences
Clothing (pictures: Traditional Costumes)	Pan American Highway
	Pan American Union
El Dorado	Pan Americanism
Gaucho	Panama, Isthmus of
Indian, American	Selva
Latin America	

Outline

I. Land Regions
- A. The Pacific Coastlands
- B. The Andes Mountains
- C. The Central Plains
- D. The Eastern Highlands

II. Natural Features
- A. Rivers
- B. Waterfalls
- C. Lakes
- D. Islands

III. Climate

IV. Animals

V. Plants

VI. Agriculture

VII. Mining

VIII. Manufacturing

IX. Transportation and Communication

Questions

What are the major causes of food shortages in South American countries?

Which of the South American central plains is suitable for farming? Why?

How is the land surface of South America like that of North America?

What is South America's most valuable export? Which country leads in its production?

How are Argentina, Brazil, and Chile making up for their lack of extensive coal deposits?

Where are most South American railroads?

How do most South Americans in country areas learn about world events?

Why is there little rainfall on the coasts of Peru and northern Chile? What are some of the areas of South America that have heavy rainfall?

Which South American country has the largest area? The smallest area?

When did manufacturing in South America have its most rapid growth? How did the governments of South America aid manufacturing development?

Books for Young Readers

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CLARK, ANN N. *The Secret of the Andes.* Viking, 1952. Story of an Indian boy of Peru. Newbery medal winner.

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QUINN, VERNON. *Picture Map Geography of South America.* Rev. ed. Lippincott, 1959.

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CROW, JOHN A. *The Epic of Latin America.* Rev. ed. Doubleday, 1971.

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MAY, CHARLES P. *Peru, Bolivia, Ecuador: The Indian Andes.* Nelson, 1969. A survey covering social, political, economic, and cultural life.

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SOUTH AMERICAN OSTRICH. See RHEA (bird).

SOUTH ARABIA, FEDERATION OF, was a union of 17 small states at the southern tip of the Arabian Peninsula. It included the British-protected state of Aden; the state of Dathina; the emirates of Beihan and Dhala; the sultanates of Audhali, Fadhli, Haushabi, Lahej, Lower Aulaqi, Lower Yafa, Upper Aulaqi, and Wahidi; and the sheikdoms of Alawi, Aqrabi, Mufhahi, Shaibi, and Upper Aulaqi. The federation covered 60,000 square miles (160,000 square kilometers). Great Britain controlled the federation's foreign affairs and defense, and provided economic assistance.

The union was once called the Federation of the Arab Emirates of the South. It was formed in 1959 by six of the states. By 1965, the other 11 states had joined. On Nov. 30, 1967, the federation gained independence as the People's Republic of Southern Yemen (see the *History* section of the YEMEN [ADEN] article).

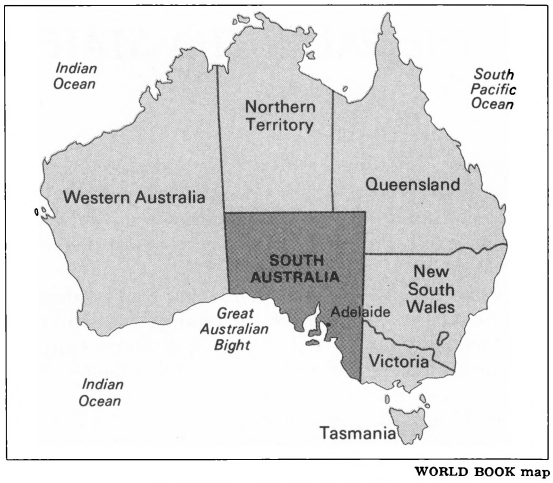
SOUTH AUSTRALIA is a state in south-central Australia. It faces the Indian Ocean and the Great Australian Bight. For detailed maps, see AUSTRALIA.

The state covers an area of 380,070 square miles (984,377 square kilometers). Much of its land lies from 1,000 to 2,000 feet (300 to 610 meters) above sea level. The Gawler and Flinders mountain ranges rise in the south. The Adelaide and southeastern coastal regions include fertile lands. The Musgrave mountain ranges are in the north. Wheat farms and rolling plains stretch between the northern ranges. The north also has flat sheep-grazing lands. Sandy deserts extend into the center of the state from the north. The *Nullarbor* (treeless) Plain covers much of the western section.

The Murray River is the continent's largest waterway. The Murray rises near the eastern border of Victoria and flows for 1,520 miles (2,446 kilometers) before it empties into the Indian Ocean near Adelaide. A number of smaller rivers flow into Lake Eyre, which lies in the northeastern section of South Australia.

South Australia's yearly temperature averages 70° F. (21° C). Less than 10 inches (25 centimeters) of rain falls annually in all but the state's southern part.

The state has excellent farming and grazing lands. Shallow lakes produce great quantities of salt. The eastern mountains have deposits of gypsum, ironstone, limestone, manganese ore, opals, and phosphate rock.



WORLD BOOK map

Location of South Australia

The People. South Australia has a population of 1,172,774. Two out of three persons live in the Adelaide metropolitan area. Most of the people of South Australia are of British descent.

Education is free and compulsory for children under 14 years of age. Adelaide has a state university and a state school of mines and industries. Flinders University in Bedford Park opened in 1966.

In the southern and eastern sections, people produce large crops of barley, hay, oats, potatoes, and wheat. The Murray River irrigates orchards, orange groves, and vineyards. About 16½ million sheep and 660,000 cattle graze there. The state produces over 173 million pounds (78 million kilograms) of wool annually. Exports include butter, copper, flour, fruits, meats, wheat, wine, and wool.

Industrial products include automobile bodies, chemicals, cotton and woolen goods, electrical equipment, and sheet metal. Mining and quarrying are important. Uranium mining began during World War II.

The state has about 3,900 miles (6,280 kilometers) of railroads and about 62,000 miles (99,800 kilometers) of roads. Port Pirie is the chief port.

Government. The British ruler appoints a governor for the state on the recommendation of the South Australian Parliament. But a premier actually heads the government. The South Australian Legislature consists of a 20-member upper house and a 39-member lower house. The voters elect members of the upper house to six-year terms, and members of the lower house to three-year terms. They also elect 22 members to the Australian Parliament in Canberra. All adult British subjects who live in the state must vote in elections.

History. Matthew Flinders, a British navigator, made the first extensive explorations along the South Australian coast about 1802. In 1836, British settlers founded the first settlement in the area in Adelaide. The discovery of gold in the neighboring colony of Victoria in 1851 brought many new settlers to South Australia. In 1856, South Australians won the right to govern themselves. South Australia joined with five other Australian colonies to form the Commonwealth of Australia in 1901. C. M. H. CLARK

See also ADELAIDE; GREAT AUSTRALIAN BIGHT; LAKE EYRE; MURRAY RIVER.

SOUTH BEND, Ind. (pop. 125,580; met. area 280,031), is one of the largest cities in the state. This industrial center lies in north-central Indiana, 90 miles (145 kilometers) east and slightly south of Chicago. It is named for its location at the southernmost point of the Indiana bend in the St. Joseph River (see INDIANA [political map]). Factories make farm machinery and tools, and automobile and airplane brakes and equipment.

The University of Notre Dame and Saint Mary's College are located near South Bend. Bethel College and a branch of Indiana University are also nearby.

In 1823, Alexis Coquillard, a fur trader, founded South Bend. He called it Big St. Joseph Station. The name was later changed to South Bend. The village was incorporated in 1835, and became a city in 1865. It has a mayor-council government. PAUL E. MILLION, JR.

See also NOTRE DAME, UNIVERSITY OF.

Louis Schwartz
Stately Homes in Historic Charleston

SOUTH CAROLINA

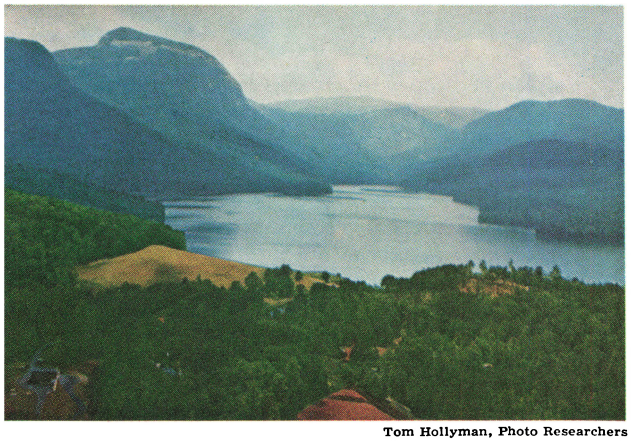
THE PALMETTO STATE

SOUTH CAROLINA is the smallest state in the Deep South. In spite of its size, South Carolina is an important manufacturing and farming state. South Carolina factories produce large amounts of a wide variety of textiles. Among all the states, only North Carolina makes more textiles than South Carolina. South Carolina raises one of the nation's largest tobacco crops, and only California grows more peaches. Columbia is the capital and largest city of South Carolina.

More than half the people of South Carolina live in farm areas, even though manufacturing is the state's chief economic activity. South Carolina still has many features of the South of pre-Civil War days. Graceful buildings erected before the war stand in Beaufort, Charleston, and other cities. Large plantations, once the backbone of the South's economy, remain in parts of South Carolina. The state's many beautiful flower gardens recall the leisurely life of the South before the Civil War.

Eastern South Carolina is a lowland that borders the Atlantic Ocean. In the west, the land rises to sand hills, and then to mountains. The people of South Carolina call the eastern part of the state the *Low Country*. They call the western section the *Up Country*.

South Carolina was named for King Charles I of England, in 1629. *Carolina* is a Latin form of *Charles*. The word *South* was added in 1730, when North and South Carolina became separate colonies.



Tom Hollyman, Photo Researchers

Lake and Table Rock near the Blue Ridge Mountains

Louis Schwartz

Palmetto Trees Along the Atlantic Coast

FACTS IN BRIEF

Capital: Columbia.

Government: *Congress*—U.S. senators, 2; U.S. representatives, 6. *Electoral Votes*—8. *State Legislature*—senators, 46; representatives, 124. *Counties*—46.

Area: 31,055 sq. mi. (80,432 km²), including 830 sq. mi. (2,150 km²) of inland water but excluding 138 sq. mi. (357 km²) of Atlantic coastal water; 40th in size among the states. *Greatest Distances*—east-west, 273 mi. (439 km); north-south, 210 mi. (338 km). *Coastline*—187 mi. (301 km).

Elevation: *Highest*—Sassafras Mountain, 3,560 ft. (1,085 m) above sea level. *Lowest*—sea level along the Atlantic Coast.

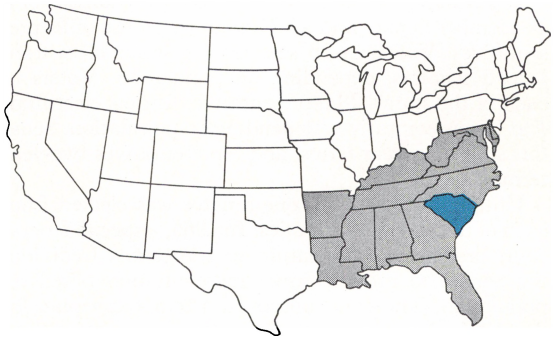
Population: *Estimated 1975 Population*—2,658,000; 27th among the states; distribution, 52 per cent rural, 48 per cent urban; density, 86 persons per sq. mi. (33 persons per km²). *1970 Census*—2,590,516.

Chief Products: *Agriculture*—beef cattle, broilers, corn, cotton, eggs, hogs, milk, peaches, soybeans, tobacco. *Fishing Industry*—crabs, oysters, shrimps. *Manufacturing*—chemicals, clothing, nonelectrical machinery, textiles. *Mining*—kaolin and other clays, sand and gravel, stone.

Statehood: May 23, 1788, the eighth state.

State Mottoes: *Animis opibusque parati* (*Prepared in mind and resources*); *Dum spiro spero* (*While I breathe, I hope*).

State Song: "Carolina." Words by Henry Timrod; music by Anne Custis Burgess.



South Carolina (blue) ranks 40th in size among all the states and 11th in size among the Southern States (gray).

Many important Revolutionary War battles were fought in South Carolina. Colonial victories in the Battle of Kings Mountain and the Battle of Cowpens were turning points of the war in the South. South Carolina may have earned its nickname, the *Palmetto State*, during the war. In 1776, colonists in a small fort built of palmetto logs defeated a British fleet that tried to capture Charleston Harbor. The next day, William Moultrie, the colonial commander, saw a column of smoke rising from a burning British ship. The shape of the smoke reminded Moultrie of the palmetto tree, which grows widely in South Carolina. These events supposedly gave South Carolina its nickname.

South Carolina was the first state to *secede* (withdraw) from the Union before the Civil War. It did so on Dec. 20, 1860. Confederate troops fired the first shot of the Civil War when they attacked Fort Sumter in Charleston Harbor on April 12, 1861.

For the relationship of South Carolina to other states in its region, see SOUTHERN STATES.

The contributors of this article are Donald O. Bushman, Former Associate Professor of Geography at the University of South Carolina; Ernest M. Lander, Jr., Alumni Professor of History at Clemson University; and William D. Workman, Jr., Editorial Analyst for The State *of Columbia, and author of* The Case for the South.

Constitution of South Carolina was adopted in 1895. The state's six earlier constitutions were adopted in 1776, 1778, 1790, 1861, 1865, and 1868.

The constitution has been *amended* (changed) about 350 times. The state legislature or a constitutional convention may propose an amendment. An amendment proposed by the legislature requires approval by two-thirds of the members of both the Senate and House of Representatives. Next, it needs the approval of a majority of the persons voting on it in a state-wide election. To become law, the amendment must then be approved by a majority of members of the state legislature.

A two-thirds vote in each house of the legislature is required to call a constitutional convention. The convention also must be approved by a majority of the persons voting on the issue in a state-wide election.

Executive. The governor of South Carolina is elected to a four-year term. He receives a $39,000 yearly salary. The governor may not serve two terms in a row. He is the only elected executive official in South Carolina who cannot serve consecutive terms. For a list of all the governors of South Carolina, see the *History* section of this article.

South Carolina voters also elect the lieutenant governor, adjutant general, attorney general, commissioner of agriculture, comptroller general, secretary of state, state treasurer, and superintendent of education. All these officials serve four-year terms.

Legislature, called the *General Assembly*, consists of a 46-member Senate and a 124-member House of Representatives. Voters in 16 senatorial districts elect from 1 to 5 senators, depending on population. Voters in each of the state's 28 representative districts elect from 1 to 12 representatives, depending on population. Senators serve four-year terms, and representatives two-year terms.

Until the mid-1960's, one senator was elected from each of the state's 46 counties. In 1965, a special federal court ordered the legislature to *reapportion* (redivide) the Senate to provide equal representation based on population. The court approved a temporary plan for the 1966 elections, and all senators were elected to two-year terms. In 1968, the court approved the legislature's plan of electing 46 senators from 20 districts. In 1972, the legislature reduced the number of senatorial districts from 20 to 16.

The legislature meets each year, starting on the second Tuesday in January. Sessions have no time limit, but the legislators are paid for only 40 working days. The governor may call special sessions.

Courts. The Supreme Court is South Carolina's highest court. It is a court of appeals, and has a chief justice and four associate justices. The justices are elected by the legislature to 10-year terms. Circuit courts of common pleas and general sessions are the chief trial courts. The legislature elects the state's 16 circuit court judges to four-year terms. Supreme Court justices are usually chosen from among the circuit court judges. Circuit court judges are usually chosen from the legislature.

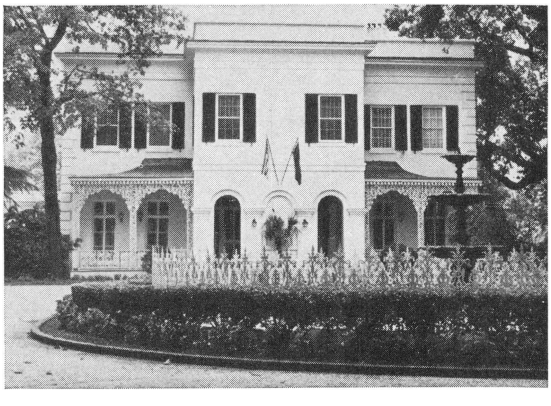
Magistrates' courts hear minor civil and criminal cases. The magistrates who head the courts are appointed by the governor, with the approval of the state Senate. Most South Carolina counties also have county courts that hear minor civil and criminal cases.

Local Government. County governments in South Carolina are headed by boards of county commissioners, county councils, or similar local boards. County commissioners or councilmen and their assistants carry out such government functions as enforcing laws and regulating taxes. Many of the county councils appoint professional administrators to direct the county government agencies. Chief county officials in South Carolina include the auditor, clerk of court, county attorney, sheriff, and treasurer.

South Carolina cities and towns operate under charters. Most of the state's larger cities have the council-manager form of government. Most of the smaller cities have the mayor-council form.

Taxation provides about three-fourths of the state government's income. Almost all the rest comes from federal grants and other U.S. government programs. A 4 per cent general sales and use tax provides more than 30 per cent of the state's tax income. A *use tax* is a tax on goods brought into the state from another state. An individual income tax brings in about 20 per cent of

Governor's House, in Columbia, was once part of a state military school. It has been the governor's residence since 1879.
South Carolina State Development Board



Statue of John C. Calhoun, Vice-President and U.S. senator, stands in the lobby of the South Carolina Capitol.
South Carolina Dept. of Parks, Recreation, and Tourism

The State Seal

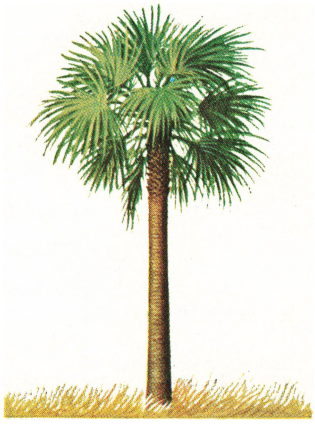
Symbols of South Carolina. On the seal, a palmetto tree towers over an uprooted oak. The palmetto symbolizes the successful defense in 1776 of the palmetto-log fort on Sullivan's Island against the oaken ships of the British. The figure of Hope carrying a laurel branch across a sword-covered beach represents the wish to remain forever independent. The seal was authorized in 1776. The state flag, adopted in 1777, also bears a palmetto, the state tree.

Flag, bird, and flower illustrations, courtesy Eli Lilly and Company

The State Flag

The State Bird
Carolina Wren

The State Flower
Carolina Jessamine



The State Tree
Palmetto

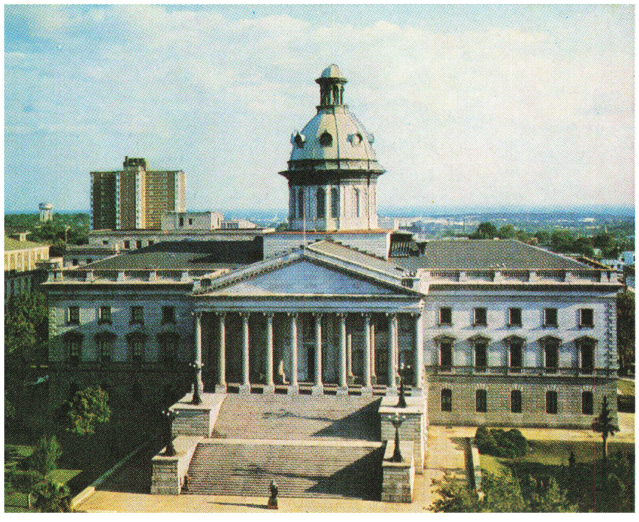
South Carolina's tax income. A gasoline tax also accounts for about 20 per cent. Funds from the gasoline tax are used to build and maintain highways.

Politics. The Democratic Party has controlled South Carolina politics throughout most of the state's history. Since 1880, non-Democratic presidential candidates have won South Carolina's electoral votes only four times. The state was carried by Strom Thurmond of South Carolina, the States' Rights Democratic (Dixiecrat) Party candidate, in 1948; Senator Barry M. Goldwater of Arizona, a Republican, in 1964; and Richard M. Nixon, a Republican, in 1968 and 1972. For South Carolina's voting record in presidential elections, see ELECTORAL COLLEGE (table).

The Republican Party gained much strength in South Carolina during the 1950's and 1960's. In 1964, Senator Strom Thurmond of South Carolina resigned from the Democratic Party and became a Republican. In 1974, James B. Edwards became the first Republican to be elected governor of the state in 100 years.

State Capitol is in Columbia, which has been South Carolina's capital since 1790. Charleston was the capital from 1670 to 1790.

Ellis Sawyer, FPG



SOUTH CAROLINA
Political Map
State capital
Urban area in South Carolina
Urban area outside South Carolina
City or town
County seat
LEE County name
County boundary
State boundary
Park or other recreation area
Forest or other conservation area
Military or other federal area
Point of interest
Major airport
Water
River
Waterway
Highways:
Expressway
Other road
Interstate
U. S.
Other
Lambert conformal conic projection
WORLD BOOK map ©Field Enterprises Educational Corporation
NORTH CAROLINA
NORTH CAROLINA
GEORGIA
AREA OF INSET MAP
Greenville
Spartanburg
Anderson
Greenwood
Laurens
Union
Newberry
Abbeville
Augusta
North Augusta
Aiken
Easley
Simpsonville
Woodruff
Fountain Inn
Honea Path
Ware Shoals
Belton
Williamston
Pelzer
Piedmont
Travelers Rest
Taylors
Greer
Victor Mills
Duncan
Lyman
Inman
Inman Mills
Boiling Springs
Cherokee
Valley Falls
Lone Oak
Converse
Whitney
Clifton
Glendale
Pacolet Mills
Central Pacolet
Pacolet
White Stone
Roebuck
Arcadia
Startex
Fairforest
Wellford
Una
Drayton
Saxon
Arkwright
Fairmont
Reidville
Pelham
Moore
Pauline
Switzer
Mauldin
Conestee
Gramling
Tigerville
Campobello
Fingerville
Landrum
Poinsett Reservoir
Lake William Cason Bowen
Caesars Head
Cleveland
Marietta
Slater
Dacusville
Powdersville
Paris
Minter
City View
Pickens
Sumter National Forest
Clemson
Pendleton
Seneca
Westminster
Oconee
Walhalla
Mountain Rest
Salem
Tamassee
Pickens
Arial
Lake Keowee
Six Mile
Cateechee
Liberty
West Union
Newry
Central
Ivorris
Wesleyan
Courtenay
Richland
Oakway
Tokeena Crossroads
Fair Play
Townville
Sandy Springs
Denver
La France
Utica
Madison
Hartwell Lake
Dean
Starr
Iva
Barnes
Lowndesville
Hartwell Dam
Abbeville
Greenwood
Saluda
Newberry
Laurens
Union
Spartanburg
Greenville
Cowpens National Battlefield Site
Chesnee
Cherokee Falls
Gaffney
East Gaffney
Cowpens
Cherokee
Spartanburg
Kelton
Adamsburg
Union
Sumter National Forest
Laurens
Newberry
Abbeville
Greenwood
Saluda
Bradley
Troy
Callison
Kirksey
Merchant
Mayson
Mount Willing
Saluda
Owdoms
Batesburg
Ridge Spring
Monetta
Ward
Johnston
Plum Branch
Edgefield
Modoc
Trenton
Parksville
McCormick
Clarks Hill
Meriwether
Clark Hill Dam
Clark Hill Lake
Morgana
Graniteville
Warrenville
Aiken West
Aiken
Aiken South
Belvedere
Madison
Gloverville
Langley
Burnettown
Bath
Clearwater
New Ellenton
Jackson
Savannah River Plant
Atomic Energy Commission
Eureka
Vaucluse
Couchton
Jonesville
Johns
Glenn Springs
Bonham
West Springs
Buffalo
Union
Monarch Mills
Cross Anchor
Cross Keys
Santuck
Carlisle
Delta
Whitmire
Shelton
Clayton
Blair
Glymphville
Strother
Monticello
Fairfield
Jenkinsville
Parr
Peak
Wallaceville
Richtex
Richland
White Rock
Lexington
Ballentine
Irmo
Chapin
Little Mountain
Lake Murray
Prosperity
Stockman
Silverstreet
Newberry
Pomaria
Helena
Jalapa
Joanna
Kinards
Mountville
Waterloo
Cross Hill
Lydia Mills
Clinton
Watts Mills
Princeton
Hickory Tavern
Blair Mills
Toney Creek
Cheddar
Gray Court
Owings
Fork Shoals
Woodville
Pelzer North
West Pelzer
Ora
Enoree
Lanford
Tyger River
Broad River
Saluda River
Enoree River
Rocky River
Secession Lake
Lake Greenwood
Bush River
Little River
Calhoun Falls
Promised Land
Verdery
Sumter National Forest
Abbeville
Greenwood
South Greenwood
Ninety Six
Chappells
Saluda
Abbeville
Greenville
Pickens
Anderson
Laurens
Union
Newberry
Greenwood
Saluda
Aiken
Augusta
Georgia
Distance scale for inset map
0 5 10 20 30 40 50 60 70 Miles 80
0 5 10 20 30 40 50 60 70 80 90 100 110 Kilometres 130

9
10
11
12
13
14
15
16
A
B
C
D
E
F
G
H
I
J
K
NORTH CAROLINA
Charlotte
Gastonia
Rock Hill
Monroe
Fayetteville
Lumberton
Florence
Columbia
Sumter
Orangeburg
Georgetown
North Charleston
Charleston
Savannah
Beaufort
Myrtle Beach
Conway
Darlington
Dillon
Marion
Bennettsville
Cheraw
Chesterfield
Lancaster
Chester
York
Fort Mill
Great Falls
Winnsboro
Camden
Lake Wylie
Lake Tillery
Blewett Falls Lake
Lake Robinson
Lake Marion
Lake Moultrie
Santee
Pee Dee River
Waccamaw River
Intracoastal Waterway
Broad River
Saluda River
Catawba River
Wateree Lake
Lynches River
Black River
Edisto River
Ashley River
Cooper River
Wando River
Bulls Bay
Winyah Bay
Port Royal Sound
Saint Helena Sound
Rocky River
Little River
Rockfish Creek
Lumber River
Cape Fear River
South River
Fishing Creek Reservoir
Lake Murray
Lake Greenwood
Lake Wylie
Kings Mountain National Military Park
Francis Marion National Forest
Cape Romain National Wildlife Refuge
Santee National Wildlife Refuge
Moncks Corner Wildlife Refuge
Jefferson Carolina Sandhills National Wildlife Refuge
Savannah National Wildlife Refuge
Parris Island Marine Recruit Depot
Beaufort Marine Corps Air Station
Shaw Air Force Base
Myrtle Beach Air Force Base
Charleston Air Force Base
Charleston Naval Station
Fort Sumter National Monument
Fort Moultrie
Battle of Camden
Battle of Eutaw Springs
Fort Jackson Military Reservation
Cherry Grove Beach
Ocean Drive Beach
Crescent Beach
Windy Hill Beach
Atlantic Beach
Litchfield Beach
Pawleys Island
Murrells Inlet
Brookgreen Gardens
Surfside Beach
Myrtle Beach
Parts of North Myrtle Beach
Little River
Calhoun
Clarendon
Williamsburg
Lee
Kershaw
Lancaster
Chesterfield
Marlboro
Darlington
Florence
Marion
Horry
Georgetown
Berkeley
Dorchester
Orangeburg
Aiken
Barnwell
Allendale
Hampton
Jasper
Colleton
Beaufort
Richland
Lexington
Fairfield
Union
Laurens
Greenwood
Abbeville
Anderson
Oconee
Pickens
Greenville
Spartanburg
Cherokee
Edisto Island
Johns Island
Folly Beach
James Island
Wadmalaw Island
Hilton Head Island
Daufuskie Island
Tybee Island
Hunting Island
Saint Helena Island
Port Royal Island
Isle of Palms
Sullivans Island
Mount Pleasant
North Island
Cat Island
South Island
Murphy Island
Bull Island
80° West Longitude
32° North Latitude
34° North Latitude
North Atlantic Ocean
North
Distance scale for South Carolina map
0 10 20 40 60 80 100 120 140 Miles 160
0 10 20 40 60 80 100 120 140 160 180 200 220 Kilometres 260

SOUTH CAROLINA MAP INDEX

Population

2,658,000 Estimate..1975
2,590,516 ..Census..1970
2,382,594 ..... "....1960
2,117,027 ..... "....1950
1,899,804 ..... "....1940
1,738,765 ..... "....1930
1,683,724 ..... "....1920
1,515,400 ..... "....1910
1,340,316 ..... "....1900
1,151,149 ..... "....1890
995,577 ..... "....1880
705,606 ..... "....1870
703,708 ..... "....1860
668,507 ..... "....1850
594,398 ..... "....1840
581,185 ..... "....1830
502,741 ..... "....1820
415,115 ..... "....1810
345,591 ..... "....1800
249,073 ..... "....1790

Metropolitan Areas

Augusta (Ga.) ..275,787
(184,764 in Ga.;
91,023 in S.C.)
Charleston 336,125
Columbia 322,880
Greenville-
Spartanburg ..473,454

Counties

Abbeville ...21,112..D 6
Aiken .....91,023..F 8
Allendale ...9,783..H 9
Anderson .105,474..C 6
Bamberg ...15,950..G 10
Barnwell ...17,176..G 9
Beaufort ...51,136..J 10
Berkeley ...56,199..H 13
Calhoun ....10,780..F 10
Charleston 247,650..I 12
Cherokee ...36,791..A 8
Chester ....29,811..C 9
Chesterfield 33,667..B 12
Clarendon ..25,604..F 12
Colleton ....27,622..H 11
Darlington ..53,442..C 13
Dillon ....28,838..C 14
Dorchester ..32,276..G 11
Edgefield ...15,692..F 7
Fairfield ...19,999..C 9
Florence ...89,636..D 13
Georgetown ..33,500..F 14
Greenville .240,774..B 6
Greenwood ..49,686..D 7
Hampton ...15,878..I 10
Horry .....69,992..E 15
Jasper .....11,885..J 10
Kershaw ...34,727..C 11
Lancaster ..43,328..C 11
Laurens ....49,713..C 7
Lee .....18,323..D 12
Lexington ..89,012..E 9
Marion .....30,270..D 14
Marlboro ...27,151..C 13
McCormick ..7,955..E 6
Newberry ...29,273..D 8
Oconee .....40,728..B 4
Orangeburg .69,789..F 10
Pickens ....58,956..B 5
Richland ..233,868..D 10
Saluda .....14,528..D 8
Spartanburg ....173,724..B 7
Sumter .....79,425..E 11
Union .....29,230..C 8
Williamsburg .....34,243..F 13
York .....85,216..A 9

Cities and Towns

Abbeville ....5,515.°K 2
Adams Run .....I 12
Adamsburg .....B 9
Aiken .....13,436.°F 8
Aiken South .....F 8
Aiken West .2,689..F 8
Alcolu .....F 12
Alcot .....D 12
Allen .....E 15
Allendale ...3,620.°H 9
Alvin .....G 13
Anderson ...27,556.°C 6
Andrews ....2,879..F 14
Angelus .....C 12
Appleton .....H 9
Aragon Mills .....B 10
Arcadia .....1,887..F 4
Arcadia Lakes 741..E 10
Ardincaple ....726..E 10
Ariail .....1,150..B 6
Arkwright ...2,059..F 4
Ashepoo .....I 11
Ashland .....D 12
Ashleigh .....G 9
Ashton .....H 10
Atlantic Beach 215..E 16
Avon .....C 9
Avondale-Moore-land* .....5,236..I 13
Awendaw .....H 14
Aynor .....536..E 15
Badham .....G 11
Baldock .....H 9
Baldwin-Aragon Mills .....1,042..B 9
Ballentine .....K 8
Bamberg ....3,406.°G 10
Barkersville .....I 10
Barnwell ....4,439.°G 9
Barton .....H 9
Batesburg ...4,036..E 9
Bath .....1,576..F 8
Beaufort ....9,434.°J 11
Beaufort Station* ..2,295..J 11
Bellinger .....K 10
Belton .....5,257..H 1
Belvedere .....F 7
Bendale .....E 10
Bennettsville 7,468.°C 14
Bennettsville Southwest .1,726..C 13
Berea* .....7,186..F 2
Bethera .....G 13
Bethune .....506..C 12
Beverly .....B 6
Bingham .....C 14
Bishopville ..3,404.°D 12
Blacksburg ..1,977..A 9
Blackstock .....C 10
Blackville ....2,395..G 9
Blair .....I 7
Blair Mills .....H 1
Blenheim .....236..C 14
Blue Brick .....D 14
Bluffton .....529..J 10
Blythewood .....D 10
Boiling Springs ....E 4
Bonham .....G 6
Bonneau .....365..G 13
Borden .....E 12
Bowling Green .....A 9
Bowman ....1,095..G 11
Boyden Arbor .416..E 10
Boyer .....G 12
Bradley .....E 7
Branchville ..1,011..G 11
Brighton .....I 9
Britton Neck .....E 15
Brookgreen .....F 15
Brownsville .....C 14
Brunson .....559..H 10
Bucksport .....F 15
Buffalo .....1,461..G 6
Burgess .....F 15
Burnettown ....434..F 8
Burton .....J 11
Cades .....E 13
Caesars Head .....E 1
Calhoun Falls .....2,234..K 1
Callison .....E 7
Camden .....8,532.°D 11
Cameron .....476..F 11
Campobello ...530..E 3
Canadys .....H 11
Cane Savannah ....E 12
Capehart* ...4,490..J 11
Carlisle .....670..H 7
Cartersville .....D 13
Cassatt .....D 12
Catawba .....B 10
Cateechee .....B 5
Cave .....H 9
Cayce .....9,967..E 10
Centenary .....E 14
Central .....1,550..B 5
Central Pacolet .....483..F 5
Chapin .....342..K 7
Chappells ....74..K 5
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Charleston Yard* ....13,565..H 13
Cheddar .....H 1
Cheraw .....5,627..B 13
Cherokee .....E 4
Cherokee Falls .....A 9
Chesnee .....1,069..A 8
Chester .....7,045.°B 9
Chesterfield .1,667.°B 12
City View ...2,497..F 2
Claremont .....E 11
Clarks Hill .....F 7
Clayton .....I 7
Clearwater .....F 8
Clemson ....5,578..B 5
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Clifton .....F 5
Clinton .....8,138..I 4
Clio .....936..C 14
Clover .....3,506..A 9
Clyburn .....C 11
Cokesbury .....J 3
College Heights .....C 13
Columbia .113,542.°E 10
Conestee .....G 2
Congaree .....E 11
Converse .....E 5
Conway .....8,151.°E 15
Coopers .....E 14
Coosawhatchie .....I 10
Cope .....202..G 10
Cordesville .....G 13
Cordova .....205..G 10
Cornwell .....C 10
Coronaca .....J 3
Cosby .....I 9
Cottageville ....497..H 12
Couchtown .....F 8
Courtenay .....B 5
Coward .....466..E 13
Cowpens ....2,109..A 8
Creston .....F 11
Crestview .....D 13
Crocketville .....H 10
Cross .....G 12
Cross Anchor .....H 5
Cross Hill ....579..J 4
Cross Keys .....H 5
Cummings .....I 10
Dacusville .....F 1
Dale .....I 11
Dalzell .....E 12
Danwood .....D 13
Darlington ..6,990.°D 13
Daufuskie Island .....K 10
Davis Station .....F 12
Dean .....D 5
De Kalb .....D 11
Delphia .....B 9
Delta .....H 6
Denmark ...3,571..G 10
Dentsville .....E 10
Denver .....C 5
Dillon .....6,391.°C 14
Dixiana .....E 10
Donalds .....392..I 2
Doneraile ...1,417..D 13
Dovesville .....C 13
Drake .....C 14
Drayton .....F 4
Dubose .....E 12
Dudley .....B 11
Due West ...1,380..J 2
Dunbar .....C 14
Duncan ....1,266..F 3
Earle .....F 14
Early Branch .....I 10
Easley ...11,175..F 1
East Gaffney 3,750..A 8
Eastover ....817..E 11
Edgefield ...2,750.°E 8
Edgemoor .....B 10
Edisto Island .....I 12
Edmund .....E 9
Effingham .....D 13
Ehrhardt ....478..H 10
Elgin .....B 11
Elgin .....374..D 11
Elko .....202..G 9
Elliott .....D 12
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Enoree .....H 4
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Eureka .....F 8
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Fairmont .....F 4
Filbert .....A 9
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Finland .....G 10
Florence ..25,997.°D 13
Floyd Dale .....D 14
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Forest Acres 6,808..E 10
Forest Lake ...39..E 10
Foreston .....F 13
Fork .....D 15
Fork Shoals .....H 2
Fort Lawn ....510..B 10
Fort Mill ...4,505..A 10
Fort Motte .....F 11
Fountain Inn 3,391..G 3
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Frogmore .....J 11
Furman .....239..I 10
Gable .....E 12
Gadsden .....E 11
Gaffney ...13,253.°A 8
Galivants Ferry ....D 15
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Garnett .....I 9
Gaston .....E 10
Georgetown 10,449.°G 15
Gifford .....H 9
Gilbert .....186..E 9
Gillisonville .....I 10
Gilmania .....I 10
Givhans .....G 12
Glass Hill .....E 15
Glendale .....F 5
Glenn Springs .....G 5
Gloverville ..1,682..F 8
Glymphville .....I 7
Goose Creek 3,656..H 13
Goretown .....D 16
Gough .....G 13
Govan .....136..G 10
Gramling .....E 8
Graniteville .1,127..F 8
Gray Court ...859..H 3
Grays .....I 10
Grays Hill .....J 11
Great Falls .2,727..C 10
Greeleyville ...542..F 13
Green Pond .....I 11
Green Sea .....D 16
Greenville ..61,436.°B 6
Greenwood .21,069.°D 7
Greer .....10,642..F 3
Gresham .....E 14
Grover .....H 11
Guess .....B 12
Guthriesville .....B 9
Hagood .....E 11
Hamer .....C 15
Hampton ...2,845.°H 10
Hanahan* ..11,518..H 13
Hardeeville .1,057..J 10
Harleyville ....704..G 12
Harris .....J 3
Hartsville ...8,017..C 13
Heath Springs 955..C 11
Helena .....J 6
Hemingway .1,026..E 14
Hendersonville .....I 11
Hickory Grove 377..B 9
Hickory Grove .....E 15
Hickory Tavern .....H 3
Hilda .....331..G 9
Hilton Head Island J 11
Hodges .....214..J 3
Holly Hill ..1,178..G 12
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Honea Path .3,707..I 2
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Hopkins .....E 10
Horatio .....E 11
Huger .....H 13
Hyman .....E 14
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Inman .....1,661..E 3
Inman Mills 1,811..E 3
Irmo .....1,008..K 8
Irving .....J 3
Irwin .....1,424..B 11
Islandton .....H 10
Isle of Palms ....2,657..I 13
Iva .....1,114..D 6
Jackson .....1,928..G 8
Jacksonboro .....I 12
Jalapa .....J 6
Jamestown ....190..G 14
Jamison .....F 11
Jedburg .....H 12
Jefferson ....709..C 12
Jenkinsville .....J 8
Jericho .....I 12
Joanna .....1,631..I 5
Johns Island .....I 13
Johnsonville 1,267..E 14
Johnston ....2,552..E 8
Jonesville ...1,447..F 6
Kellytown .....D 12
Kelton .....B 8
Kemper .....D 15
Kensington .....G 15
Keowee .....B 5
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Killian .....D 10
Kinards .....I 5
Kings Creek .....A 9
Kingstree ...3,381.°F 13
Kingville .....E 11
Kirksey .....E 7
Kirkwood .....D 11
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Ladson .....H 13
La France .....C 5
Lake City ...6,247..E 13
Lake View ....949..D 15
Lamar .....1,250..D 13
Lancaster ...9,186.°B 11
Lancaster Mills .....2,558..B 11
Lando .....B 10
Landrum ....1,859..D 3
Landsford .....B 10
Lane .....517..F 13
Lanford .....H 4
Langley .....F 8
Latta .....1,764..D 14
Laurens ...10,298.°C 7
Leeds .....C 9
Lees .....G 9
Leesville ....1,907..E 9
Lena .....I 9
Lesslie .....B 10
Level Land .....J 1
Lexington ....969.°E 9
Liberty ....2,860..B 5
Liberty Hill .....C 11
Lincolnville ..504..H 12
Litchfield Beach ...F 15
Little Mountain ..240..K 7
Little River .....E 16
Little Rock .....C 14
Livingston ....165..F 10
Lobeco .....I 11
Lockhart .....103..B 9
Lodge .....168..H 10
Lone Oak ...2,864..E 4
Lone Star .....F 11
Longcreek .....B 4
Longs .....E 16
Loris .....1,741..D 16
Lowndesville ..219..D 6
Lowrys .....260..B 9
Lucknow .....D 12
Lugoff .....D 11
Luray .....72..I 9
Lydia .....D 12
Lydia Mills .....I 4
Lyman .....1,159..F 3
Lynchburg ....546..D 13
Lyndhurst .....H 9
Madison .....C 4
Madison ....1,337..F 8
Manning ...4,025.°F 12
Marietta, see Slater [-Marietta]
Marion .....7,435.°D 14
Marlboro .....C 13
Martin .....H 9
Maryville .....G 15
Mauldin ....5,480..G 2
Mayesville ....757..E 12
Mayo .....A 8
McBee .....592..C 12
McBeth .....G 13
McClellanville 304..H 14
McColl .....2,524..B 14
McConnells ...213..B 9
McCormick ..1,864.°E 7
McKennon .....C 12
McPhersonville .....I 10
Mechanicsville .....D 13
Meggett .....180..I 12
Merchant .....E 8
Meriwether .....F 7
Middendorf .....C 12
Midway .....G 10
Miley .....H 10
Millettville .....H 9
Minter .....F 2
Modoc .....F 7
Monarch Mills .....1,726..G 6
Moncks Corner ....2,314.°G 13
Monetta .....E 8
Monticello .....J 8
Montmorenci .....F 8
Montrose .....C 13
Moore .....F 4
Morgana .....F 7
Morrisville .....F 14
Motbridge .....D 13
Mount Carmel 138..E 6
Mount Croghan ....123..B 12
Mount Holly .....H 13
Mount Pleasant ..6,879..I 13
Mount Willing .....E 8
Mountain Rest .....B 4
Mountville .....J 4
Mouzon .....F 13
Mullins .....6,006..D 15
Murrells Inlet .....F 15
Myrtle Beach .....9,035..F 16
Myrtle Beach Base* .....3,864..F 16
Neeses .....388..F 10
Nesmith .....F 14
New Ellenton ..2,546..G 8
New Holland .....F 9
New Zion .....E 13
Newberry ...9,218.°D 8
Newport .....B 10
Newry .....B 5
Nichols .....549..D 15
Nimmons .....A 5
Ninety Six ..2,166..K 4
Norris .....757..B 5
North .....1,076..F 10
North Augusta ..12,883..F 7
North Charleston ...H 13
North Hartsville .....1,485..C 13
North Myrtle Beach ....1,957..E 16
North Santee .....G 15
Norway .....579..G 10
Oak Grove .....D 14
Oakley .....H 13
Oakway .....C 5
Oatland .....F 14
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Olanta .....640..E 13
Olar .....423..G 10
Old House .....J 10
Ora .....H 4
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Osborn .....I 12
Osceola .....B 11
Oswego .....E 12
Owdoms .....E 8
Owings .....H 3
Pacolet .....1,418..F 5
Pacolet Mills 1,504..F 5
Pacolet Park ..162..F 5
Pageland ...2,122..B 12
Pamplico ....1,068..E 14
Panola .....F 12
Paris .....F 2
Parkers Ferry .....I 12
Parksville ....164..E 7
Parr .....J 8
Parris Island* ...8,868..J 11
Patrick .....421..C 13
Pauline .....G 5
Pawleys Island ....G 15
Paxville .....261..F 12
Peak .....87..J 7
Peedee .....D 14
Pelham .....F 3

Louis Schwartz

Seaport at Charleston is a principal U.S. port on the South Atlantic coast. Cargo passing through the port includes bananas, oil, ore, fertilizer, jute, coal, and tobacco. Georgetown and Port Royal are also important South Carolina port cities.

Pelion .....216..F 9
Pelzer .....130..H 1
Pelzer North 1,202..H 1
Pendleton ...2,615..C 5
Perry .....209..F 9
Pickens ....2,954.°B 5
Piedmont ...2,242..G 1
Pimlico .....H 13
Pinehurst-Shep-
pard Park 1,711..H 12
Pineland .....I 10
Pineridge .....633..E 10
Pineville .....G 13
Pinewood .....687..F 11
Pinopolis .....G 13
Plantersville .....F 15
Plum Branch .108..E 7
Pomaria .....264..J 7
Pontiac .....D 10
Port Royal ..2,865..J 11
Poston .....E 14
Powdersville .....G 1
Pregnall .....G 12
Princeton .....I 2
Pritchardville .....J 10
Promised Land ....K 3
Prosperity ....762..K 6
Quinby* .....788..D 13
Rains .....D 15
Ravenel .....931..I 12
Red Bank .....E 9
Red River ....222..B 10
Reevesville ....247..G 11
Reidville .....460..F 3
Rembert .....D 11
Rhems .....F 14
Richburg .....304..B 10
Richland .....C 5
Richtex .....K 8
Ridge Spring .644..E 8
Ridgeland ..1,165.°J 10
Ridgeville ....563..H 12
Ridgeway ....437..D 10
Ridgewood .....H 12
Rimini .....F 11
Rion .....D 10
Ritter .....I 11
Riverside .....B 10
Robertville .....I 10
Rock Hill ..33,846..B 10
Roddey .....B 10
Rodman .....B 10
Roebuck .....F 4
Rome .....F 14
Rosinville .....G 11
Round O .....H 11
Rowell .....B 10
Rowesville ....392..G 11
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Ruffin .....H 11
Russellville .....G 13
St. Andrews* 9,202..I 13
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St. George ..1,806.°G 11
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St. Paul .....F 12
St. Stephens 1,506..G 13
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Salem .....E 14
Salley .....450..F 9
Salters .....F 13
Saluda .....2,442.°E 8
Samaria .....E 9
Sampit .....G 14
Sandy River .....C 9
Sandy Springs .....C 5
Santee .....137..F 11
Santuck .....H 6
Sardinia .....E 13
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*Does not appear on the map; key shows general location.
°County seat.

Sources: Latest census figures (1970 and special censuses). Places without population figures are unincorporated areas and are not listed in census reports.

Louis Schwartz

Textile Worker inspects yarn. About half the persons employed in manufacturing in South Carolina work in the textile industry. The state rebuilt its economy around this industry after the Civil War, and is now one of the nation's leading textile producers.

SOUTH CAROLINA / *People*

The 1970 United States census reported that South Carolina had 2,590,516 persons. The population had increased by 9 per cent over the 1960 census figure, 2,382,594. The U.S. Bureau of the Census estimated that by 1975 the state's population had reached about 2,658,000.

About 52 per cent of South Carolina's people live in farm areas. The state has three Standard Metropolitan Statistical Areas (see METROPOLITAN AREA). More than 1 million South Carolinians, or more than two-fifths of the population of the state, live in these three areas. The state's metropolitan areas are Charleston, Columbia, and Greenville-Spartanburg. Part of the Augusta, Ga., Standard Metropolitan Statistical Area also extends into Aiken County, South Carolina. For the populations of the metropolitan areas, see the *Index* to the political map of South Carolina.

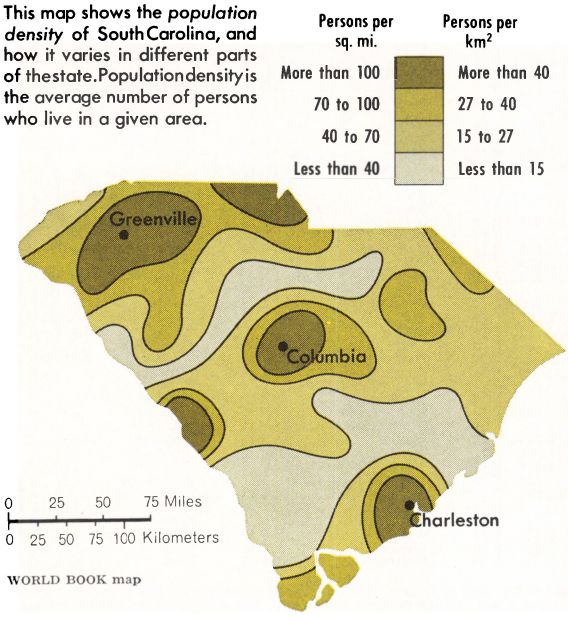
South Carolina's largest cities, in order of size, are Columbia, Charleston, and Greenville. They are the only cities in South Carolina that have a population of more than 50,000 persons. See the separate articles on South Carolina cities listed in the *Related Articles* at the end of this article.

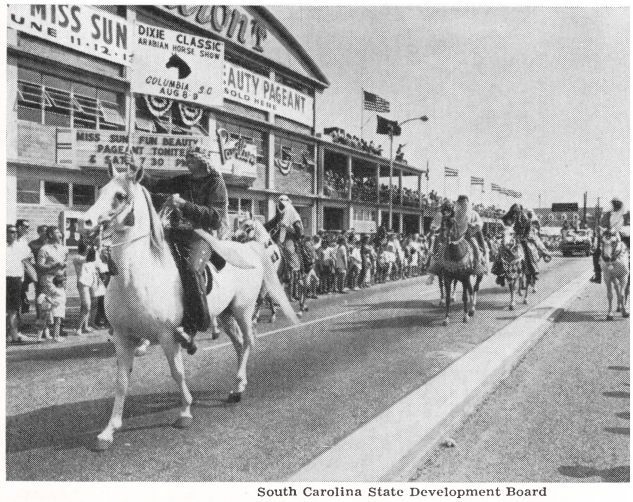
About 76 of every 100 South Carolinians were born in the state, and many are descendants of early settlers. About 99 of every 100 persons in the state were born in the United States. Britons and Germans make up the largest groups born in other countries. About 30 of every 100 persons who live in South Carolina are Negroes.

Most South Carolinians are Protestants. Baptists outnumber all other religious groups. Other large religious groups include Methodists and Presbyterians.

POPULATION

This map shows the *population density* of South Carolina, and how it varies in different parts of the state. Population density is the average number of persons who live in a given area.





South Carolina State Development Board

Paraders and Spectators enjoy the annual Sun-Fun Festival in Myrtle Beach. Other annual events in South Carolina include a steeplechase, stock car races, and a state fair.

Schools. In colonial times, most South Carolina children were educated at home or in private schools. In 1710, the colonial government established semipublic schools called *free schools*. These schools were free to poor children, but other youngsters paid tuition. The colonial government and individuals helped pay the costs of running the schools.

In 1811, the state legislature approved a plan to set up free schools in all parts of South Carolina. But not enough money was put aside to run the schools. There were few free schools except in the largest towns. The 1868 constitution called for free public schools for all children. The legislature failed to provide enough money for the schools. Finally, the 1895 constitution provided enough tax support for statewide public schools.

Like other Southern states, South Carolina had separate schools for Negroes and whites for many years. In 1954, the Supreme Court of the United States ruled that public school segregation on the basis of race is unconstitutional. The first racial integration in South Carolina public schools took place in Charleston in 1963. By 1970, most South Carolina school districts had been integrated. Children between the ages of 7 and 16 must attend school. For the number of students and teachers in the state, see EDUCATION (table).

A superintendent of education and a state board of education head the South Carolina public school system. The board of education has 16 members, one from each *judicial* (court) district. The board members are elected by the state legislators from the counties in each district. The voters elect the superintendent.

Libraries. South Carolina had the first government-supported lending library in the 13 original colonies. The library opened in Charleston in 1698, but closed a few years later. In 1840, the University of South Carolina built the nation's first separate college library building. Today, South Carolina has about 40 public county and *multicounty* (regional) libraries. There are 6 municipal public libraries and many school libraries.

Museums. The Charleston Museum, founded in 1773, ranks among the oldest museums in the United States. It has natural history and colonial history exhibits, and a planetarium. The Bob Jones University Art Museum in Greenville has a collection of paintings by European masters. Other art museums include the Columbia Museum of Art and Science and the Gibbes Gallery in Charleston. One of President Woodrow Wilson's boyhood homes is a museum in Columbia.

UNIVERSITIES AND COLLEGES

South Carolina has 23 universities and colleges accredited by the Southern Association of Colleges and Schools. For enrollments and further information, see UNIVERSITIES AND COLLEGES (table).

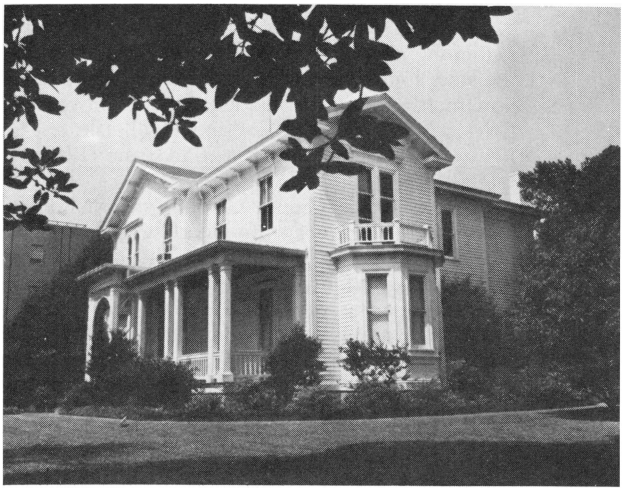
Name	Location	Founded
Baptist College at Charleston	Charleston	1964
Benedict College	Columbia	1870
Central Wesleyan College	Central	1958
Charleston, College of	Charleston	1770
Citadel, The	Charleston	1842
Claflin College	Orangeburg	1869
Clemson University	Clemson	1889
Coker College	Hartsville	1908
Columbia College	Columbia	1854
Converse College	Spartanburg	1889
Erskine College	Due West	1839
Francis Marion College	Florence	1970
Furman University	Greenville	1826
Lander College	Greenwood	1872
Limestone College	Gaffney	1845
Medical University of South Carolina	Charleston	1971
Newberry College	Newberry	1856
Presbyterian College	Clinton	1880
South Carolina, University of	Columbia	1801
South Carolina State College	Orangeburg	1896
Voorhees College	Denmark	1897
Winthrop College	Rock Hill	1886
Wofford College	Spartanburg	1854

University of South Carolina's McKissick Memorial Library is on the campus at Columbia. The campus also includes the nation's oldest separate college library building, built in 1840.

Shostal

Woodrow Wilson's Boyhood Home in Columbia was bought by the state in 1929. It is now a museum. The President lived in the house with his parents from 1870 to 1874.

South Carolina State Development Board



SOUTH CAROLINA / *A Visitor's Guide*

South Carolina's mountains, seashore, and historic sites make the state a favorite vacationland. Abundant wildlife in the fields and streams provide exciting action for hunters and fishermen. Visitors also enjoy the state's many beautiful flower gardens.

Louis Schwartz

Fort Sumter, Site of the Opening Battle of the Civil War

Tom Hollyman, Photo Researchers

Monument at Kings Mountain Battlefield

PLACES TO VISIT

Following are brief descriptions of some of South Carolina's many interesting places to visit.

Battlegrounds recall South Carolina's part in the Revolutionary War. *Kings Mountain National Military Park* and *Cowpens National Battlefield*, both near Gaffney, mark the sites of major Revolutionary War battles. Other battlefields are marked at *Camden* and at *Eutaw Springs*, near St. Matthews.

Beaches along South Carolina's Atlantic Coast offer swimming and sunbathing. Myrtle Beach is probably the state's most famous seaside resort. Other beaches, from north to south, include Cherry Grove, Ocean Drive, Crescent, Atlantic, Windy Hill, Isle of Palms, Folly, Edisto Island, Hunting Island, and Hilton Head Island.

Forts are among South Carolina's most interesting historic sites. *Fort Sumter*, in Charleston Harbor, is the place where the Civil War began. The fort is now a national monument. *Fort Moultrie*, also in Charleston Harbor, is the site of a brave defense by the colonists against the British during the Revolutionary War. *Fort Johnson*, in Charleston Harbor, is the place where Americans seized tax stamps from the British in 1765 in opposition to the Stamp Act. At *Windmill Point*, near Charleston, Governor Sir Nathaniel Johnson turned back French and Spanish fleets in 1706, during Queen Anne's War (see FRENCH AND INDIAN WARS).

Gardens are among South Carolina's most beautiful attractions. Near Charleston are the famous *Cypress Gardens*, *Magnolia Gardens*, and *Middleton Place Gardens*. Cypress Gardens include a variety of colorful flowers and several lagoons flanked by cypress trees. Magnolia Gardens feature more than 500 varieties of flowers and trees from many lands. The English novelist John Galsworthy called Magnolia Gardens "the most beautiful in the world." Middleton Place Gardens are the oldest landscaped gardens in the United States. They were begun in 1741, and feature azaleas, camellias, and ancient oak trees. The garden area includes exhibits on plantation life of the 1700's and 1800's. *Brookgreen Gardens*, north of Georgetown, cover parts of Brookgreen and three other former rice plantations. These gardens feature South Carolina plants and trees, a zoo of U.S. animals, and a collection of statues. *Edisto Gardens*, in Orangeburg, is a city-owned display of azaleas, camellias, roses, and other flowers.

National Forests. South Carolina has two National Forests—Francis Marion near Charleston, and Sumter, which covers three areas in the Piedmont. For details, see NATIONAL FOREST (table).

State Parks and Forests. South Carolina has 42 state parks and historic sites, and 4 state forests. For information, write to Director of Parks and Recreation, P.O. Box 1358, Columbia, S.C. 29202.

Shostal

Middleton Place Gardens near Charleston

ANNUAL EVENTS

Favorite annual events in South Carolina include the Carolina Cup Steeplechase, held in Camden in spring, and the Southern 500 stock car race, held in Darlington on Labor Day.

Other annual events in South Carolina include the following.

January-June: Polo Games in Aiken (each Sunday from the beginning of February through the end of April); Garden Tours, state-wide (mid-February through May); Canadian-American Days in Myrtle Beach (late March); South Carolina Folk Music Festival in Myrtle Beach (late March); Plantation Tours, throughout the state (March, April); The Governor's Annual Frog Jumping Contest in Springfield (Saturday before Easter); Rebel 500 Stock Car Race in Darlington (April); Iris Festival in Sumter (last week in May); Sun-Fun Festival in Myrtle Beach, featuring parades, contests, and the crowning of Miss Sun-Fun, U.S.A. (second week in June).

July-December: Water Festival in Beaufort (mid-July); Watermelon Festival in Pageland (mid-July); State Fair in Columbia (third week in October); Colonial Cup in Camden (mid-November); Chitlin Strut in Salley (late November); Christmas Holidays Festival in Myrtle Beach (mid-December through early January).

Polo Players Compete in Aiken

W. D. Madewell

Colorful Garden and Mansions near Beaufort

Shostal

Specially created for **World Book Encyclopedia** by Rand McNally and World Book editors

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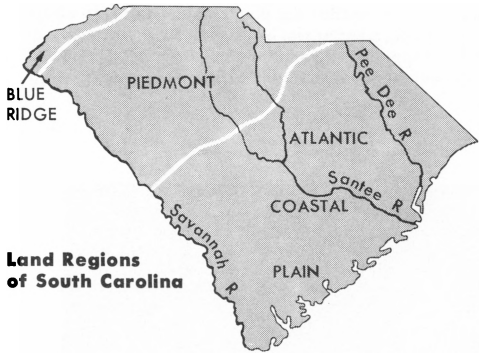


Land Regions of South Carolina

Tom Hollyman, Photo Researchers

Barge Transports Goods near Beaufort, a seacoast town. Harbors line the Atlantic Coastal Plain region and provide shipping facilities for agricultural and industrial products.

SOUTH CAROLINA / *The Land*

Land Regions. South Carolina has three main land regions: (1) the Atlantic Coastal Plain, (2) the Piedmont, and (3) the Blue Ridge. South Carolinians call the Atlantic Coastal Plain the *Low Country*, and the Piedmont and Blue Ridge the *Up Country*.

The Atlantic Coastal Plain is a lowland that covers the southeastern two-thirds of South Carolina. It is part of the plain of the same name that stretches from New York to Florida. In South Carolina, the land rises gradually from southeast to northwest. Near the Atlantic Coast, the plain is flat and broken by wide bays and rivers. Swamps cover much of the land near the coast and extend far inland along the rivers. A belt of forest called the *Pine Barrens* covers part of the central Atlantic Coastal Plain. A series of sand hills runs through Aiken, Camden, Cheraw, and Columbia, marking the western edge of the plain. These sand hills form part of an ancient beach, and indicate that the Atlantic Coastal Plain once lay under the ocean.

The Piedmont covers most of northwestern South Carolina. It is part of a land region that extends from New York to Alabama. The *Fall Line* forms the eastern edge of the Piedmont in South Carolina. The Fall Line is a zone where rivers tumble from higher land to the low-lying Atlantic Coastal Plain (see FALL LINE). In the southeast, the South Carolina Piedmont is a rolling upland with elevations from 400 to 1,000 feet (120 to 300 meters) above sea level. The region rises to a hilly area 1,500 feet (460 meters) above sea level at its western edge.

The Piedmont slopes from northwest to southeast, which causes rivers in the region to flow rapidly. The swift-running rivers are a major source of hydroelectric power. This power helps make the Piedmont an important manufacturing area.

The Blue Ridge covers the northwestern corner of South Carolina. It is part of a larger region of the same name that runs from southern Pennsylvania to northern Georgia. The famous Blue Ridge Mountains, part of the Appalachian Mountain system, give the region its name. The Blue Ridge Mountains of South Carolina are less rugged and more easily crossed than those of North Carolina. Few Blue Ridge peaks in South Carolina rise more than 3,000 feet (910 meters), and all are topped with forests. Sassafras Mountain, the highest point in the state, rises 3,560 feet (1,085 meters) above sea level in the Blue Ridge.

Coastline of South Carolina has many bays and inlets. Measured in a straight line, the coastline totals 187 miles (301 kilometers). If all the coastal area washed by water were measured, the coastline would total 2,876 miles (4,628 kilometers). Important bays and harbors along the coast include, from north to south, Little River Inlet, Winyah Bay, Bull Bay, Charleston Harbor, St. Helena Sound, and Port Royal Sound. The northern part of the coastline, from North Carolina to Winyah Bay, has an almost unbroken beach. South of Winyah Bay, salt-water marshes cover much of the coastal area, and tidal rivers cut far inland. Many islands lie along the coast. They include, from north to

south, Pawley's Island, Bull Island, Isle of Palms, Sullivan's Island, Edisto Island, Hunting Island, Fripps Island, and Hilton Head Island. Parris Island, near Beaufort, is a major U.S. Marine training center.

Rivers, Waterfalls, and Lakes. Many large rivers cross South Carolina from northwest to southeast. The largest is the Pee Dee River, which drains an area of 16,320 square miles (42,269 square kilometers) in North and South Carolina. The Santee River is a close second in size, and the Savannah River is third. Other rivers include the Broad and the Saluda. Every South Carolina river that crosses the Fall Line has a series of rapids or waterfalls. Larger and more beautiful waterfalls may be seen in the Blue Ridge Mountains. South Carolina has no large natural lakes. Dams form many large man-made lakes or reservoirs. The largest is Lake Marion. Other man-made lakes include Greenwood, Wylie, Moultrie, Murray, and Wateree. Clark Hill and Hartwell lakes, on the Savannah River, are shared by South Carolina and Georgia.

Blue Ridge Mountains, *left,* cover the northwestern corner of South Carolina and give the Blue Ridge region its name. These mountains are less rugged than the Blue Ridge of North Carolina, and are capped with pine and hemlock forests. The region's scenic beauty makes it popular with vacationers. The Blue Ridge region is too mountainous for farming, and most of the people earn their living in manufacturing.

Photos, Tom Hollyman, Photo Researchers

Contour Farming, *above,* in the hilly Piedmont region of South Carolina helps prevent soil erosion. By planting alternate strips of crops that are harvested at different times, the farmer always has a soil-holding crop on the land. Agriculture has been an important activity in South Carolina since the first permanent settlers arrived in 1670. Tobacco is the leading crop. The state also ranks high in the production of cotton, peaches, and soybeans.

Tom Hollyman, Photo Researchers

Warm Summer Weather attracts sunbathers to Myrtle Beach, South Carolina's largest seashore resort. The 312-acre (126-hectare) Myrtle Beach State Park is a year-round vacation spot.

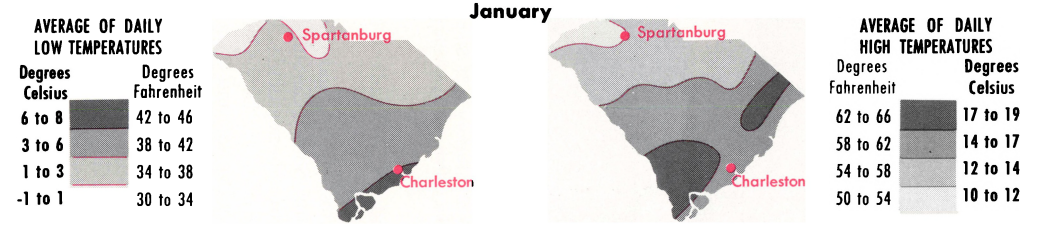
SOUTH CAROLINA / *Climate*

South Carolina has a warm climate. July temperatures average about 81° F. (27° C) in the south and about 72° F. (22° C) in the northwest. January temperatures average about 51° F. (11° C) in the south and about 41° F. (5° C) in the northwest. The state's record high temperature, 111° F. (44° C), was recorded in Blackville on Sept. 4, 1925; in Calhoun Falls on Sept. 8, 1925; and in Camden on June 28, 1954. The record low temperature, −13° F. (−25° C), was recorded near Longcreek on Jan. 26, 1940.

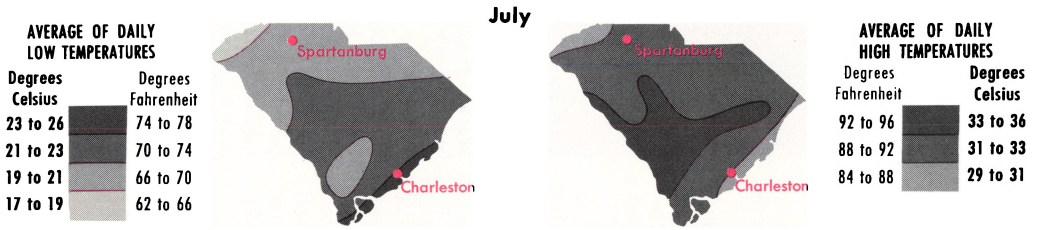
Yearly *precipitation* (rain, melted snow, and other forms of moisture) in most parts of South Carolina averages about 45 inches (114 centimeters). The mountains receive over 70 inches (178 centimeters) of precipitation annually. South Carolina gets little snow. Annual snowfall ranges from about 7 inches (18 centimeters) in the mountains to light traces of snow in the south.

SEASONAL TEMPERATURES

January

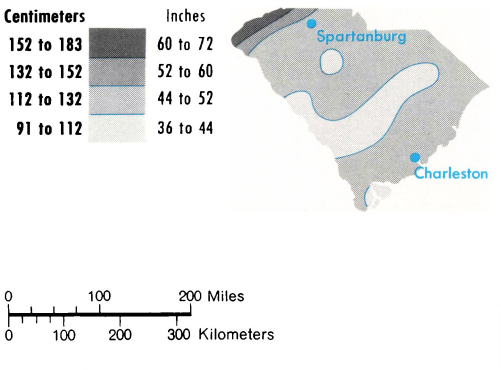


July



AVERAGE YEARLY PRECIPITATION

(Rain, Melted Snow and Other Moisture)



WORLD BOOK maps

AVERAGE MONTHLY WEATHER

CHARLESTON	Temperatures F°		Temperatures C°		Days of Rain or Snow
	High	Low	High	Low	
JAN.	59	44	15	7	9
FEB.	60	45	16	7	9
MAR.	66	50	19	10	9
APR.	73	58	23	14	7
MAY	80	66	27	19	8
JUNE	86	73	30	23	11
JULY	88	75	31	24	13
AUG.	87	75	31	24	12
SEPT.	84	71	29	22	10
OCT.	75	61	24	16	6
NOV.	66	51	19	11	7
DEC.	60	44	16	7	9

SPARTANBURG	Temperatures F°		Temperatures C°		Days of Rain or Snow
	High	Low	High	Low	
JAN.	52	35	11	2	11
FEB.	55	36	13	2	10
MAR.	62	41	17	5	11
APR.	71	50	22	10	9
MAY	80	58	27	14	8
JUNE	88	67	31	19	9
JULY	89	69	32	21	12
AUG.	87	68	31	20	10
SEPT.	83	64	28	18	7
OCT.	73	52	23	11	6
NOV.	61	41	16	5	8
DEC.	53	35	12	2	10

Manufacturing is South Carolina's chief economic activity. Agriculture ranks second, followed by the tourist industry. The Piedmont has long been South Carolina's most important manufacturing region. Manufacturing is also important in the Atlantic Coastal Plain. Farms and the tourist trade thrive in many areas.

Natural Resources. South Carolina's most important natural resource is its plentiful water supply. The state also has large forests and abundant wildlife.

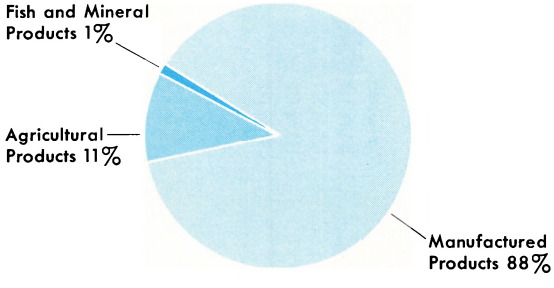
Soil. The Atlantic Coastal Plain has some of South Carolina's best soils. Deposits of silt from rivers have left a black loam along the river valleys. A lighter loam covers other parts of the plain. A red soil covers the Piedmont and Blue Ridge.

Minerals. Large deposits of kaolin lie in Aiken County. Other clays are found scattered throughout the Atlantic Coastal Plain and the Piedmont. The Piedmont also has granite deposits. Limestone is found chiefly in the Atlantic Coastal Plain. Deposits of sand and gravel are also found in the coastal plain. Vermiculite is produced in Greenville and Laurens counties.

Forests cover almost two-thirds of South Carolina. The Low Country has thick forests of hickories, live oaks, magnolias, pines, red and white oaks, and sweet gums. Bald cypresses, black tupelos, cottonwoods, sweet gums, and tulip trees grow in the swamps. Longleaf pines and scrub oaks grow in the sand hills. Piedmont forests have beeches, maples, pines, tulip trees, and white oaks.

PRODUCTION OF GOODS IN SOUTH CAROLINA

Total value of goods produced in 1971—$4,827,861,000



Percentages are based on farm income, value added by manufacture, and value of fish and mineral production. Fish products are less than 1 per cent.

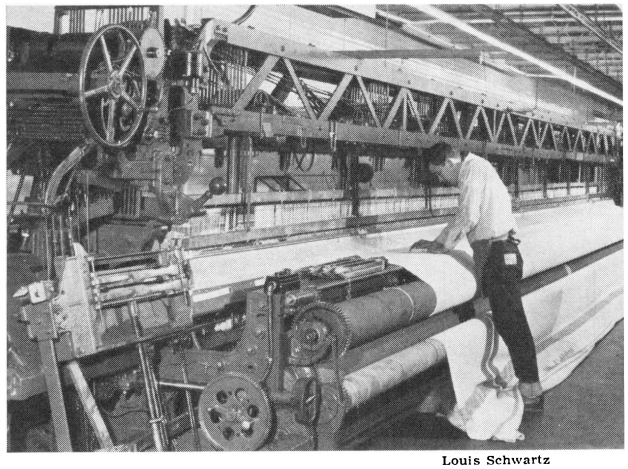
Sources: U.S. government publications, 1971-1973.

EMPLOYMENT IN SOUTH CAROLINA

Total number of persons employed in 1971—982,000

	Number of Employees
Manufacturing	353,600
Government	165,200
Wholesale & Retail Trade	160,700
Community, Business, & Personal Services	102,300
Agriculture	63,000
Construction	61,000
Transportation & Public Utilities	40,700
Mining & Finance, Insurance, & Real Estate	35,500

Sources: *Employment and Earnings*, May, 1973, U.S. Bureau of Labor Statistics; U.S. Bureau of Employment Security.



Louis Schwartz

Worker Inspects Felt at a factory in St. Stephen. South Carolina textile mills also make cotton and synthetic fabrics.

Hemlocks, pines, and many broadleaf trees cover the Blue Ridge Mountains.

Plant Life. Palmettos, yuccas, and other subtropical plants grow along the South Carolina coast. Thick growths of dwarf white honeysuckle and sweet bay spread over large areas in the Low Country. Spanish moss hangs from many live oak and cypress trees. Other South Carolina plants include Carolina jessamine and the Venus's-flytrap, a rare insect-trapping plant that grows wild only in North and South Carolina. Brilliant patches of azaleas, mountain laurels, and rhododendrons blanket the South Carolina mountains in spring.

Animal Life. White-tailed deer live in the forests near the coast. A few black bears roam the swamps, where alligators sometimes can be seen lying in the sun. Fox squirrels, foxes, and wildcats live in the state's inland forests. Opossums, raccoons, and cottontail rabbits may be seen throughout the state. Short-eared marsh rabbits live along the coast. More than 450 kinds of birds, including wild turkeys, live in South Carolina. Few other states have so many kinds of birds.

People often see bottle-nosed dolphins, sharks, and sperm whales along the South Carolina coast. About 350 kinds of salt-water fishes live in the state's coastal waters and salt marshes. Fresh-water streams and lakes have bass, bream, rockfish, and trout.

Manufacturing accounts for more than four-fifths of the value of goods produced in South Carolina. Goods manufactured there have a *value added by manufacture* of about $4\frac{1}{4}$ billion annually. This figure represents the value created in products by South Carolina industries, not counting such costs as materials, supplies, and fuel. South Carolina's chief manufactured goods, in order of importance, are (1) textiles, (2) chemicals and chemical products, and (3) nonelectrical machinery.

Textiles have a value added of about $1\frac{1}{2}$ billion yearly. South Carolina ranks second only to North Carolina in textile production. During the 1960's, the state's textile mills began to increase their production of man-made fabrics. Today, these fabrics rank as South Caro-

lina's leading textile product. South Carolina has more than 435 mills. Products of these mills include Dacron, orlon, rayon, silk, wool, plastic and glass fiber yarns; plastic-coated cottons; and rayon and nylon tire cord.

Most of the state's textile mills are in northwestern South Carolina. Important textile-manufacturing centers include Anderson, Chester, Gaffney, Greenville, Greenwood, Lancaster, Rock Hill, Spartanburg, and the Horse Creek Valley in Aiken County.

Chemicals and Chemical Products have an annual value added of about $740 million. Chemical factories in Charleston, Columbia, Spartanburg, and many other South Carolina cities and towns produce fertilizer. Factories in Aiken, Anderson, Camden, Greenville, Irmo, Rock Hill, and Spartanburg make synthetic fibers. These fibers are later woven or knitted in other mills throughout South Carolina. The United States government operates a large chemical plant near the Savannah River, south of Aiken. The plant produces chemicals used in national defense and space programs.

Nonelectrical Machinery has a yearly value added of about $325 million. Greenville and Spartanburg lead the state's cities in the manufacture of nonelectrical machinery. The industry's chief products include textile machinery and gas turbines.

Other Products. Clothing ranks fourth in value among the state's manufactured goods. More than 250 South Carolina factories make clothing and other textile products. Most of these factories use textiles woven in the state's mills. Other products manufactured in South Carolina include electrical equipment, food and food products, lumber and wood products, paper and paper products, and stone, clay, and glass products.

Agriculture. Farm products account for about 11 per cent of the value of goods produced in South Carolina. The state's farmers earn about $520 million a year. South Carolina's 40,000 farms average 177 acres (72 hectares) in size. Farmland occupies about a third of the state, and about half of that is used to grow crops. Most of the rest is covered by forests. South Carolina farmers sell much timber from the forests.

Tobacco is the state's leading cash crop. It has a yearly value of about $100 million. South Carolina grows about 66,000 short tons (60,000 metric tons) of tobacco annually, and is a top tobacco-producing state. Every South Carolina county except Charleston County produces tobacco.

Soybeans are South Carolina's second leading cash crop. They have an annual value of about $45 million. More South Carolina farmland is used for soybeans than for any other crop.

Cotton is the third leading cash crop. The state produces about 275,000 bales of cotton annually. The cotton crop earns about $45 million each year. Farmers sell about 110,000 short tons (100,000 metric tons) of cottonseed yearly to cottonseed oil mills. The seed yields an oil used in food. Marlboro and Orangeburg are the leading cotton counties. Farmers in every county except Charleston County grow cotton.

Other Crops. Peaches and corn are other important

FARM, MINERAL, AND FOREST PRODUCTS

This map shows where the state's leading farm, mineral, and forest products are produced. The major urban areas (shown in red) are the state's important manufacturing centers.

Shostal

Woodsmen Cut Trees for pulp. One of the largest U.S. pulp mills is in Georgetown. Lumber mills operate in every section of South Carolina. Many plants in the swamp areas along the coast produce crates and boxes.

South Carolina farm crops. South Carolina ranks second only to California in peach production. Most of the corn grown in the state is used to feed animals, or in making corn meal, corn syrup, and grits. Other farm crops in South Carolina include cucumbers, forest products, greenhouse and nursery products, hay, peanuts, pecans, tomatoes, watermelons, and wheat.

Livestock and Poultry. Beef cattle are South Carolina's chief livestock product. Hogs rank second. Eggs are the state's chief poultry product. South Carolina chickens lay over a billion eggs yearly. *Broilers* (chickens 9 to 12 weeks old) are also an important product. Milk is South Carolina's leading dairy product.

Mining contributes about $67 million annually to the value of goods produced in South Carolina. Granite and limestone are among the state's most valuable mineral products. Granite comes chiefly from the Piedmont. Limestone is mined in the Atlantic Coastal Plain. South Carolina is a leading producer of *kaolin* (a kind of clay). Kaolin is mined chiefly in Aiken County. About one-third of the state's counties produce sand and gravel. South Carolina also ranks as a leading producer of vermiculite.

Fishing Industry. South Carolina has an annual fish catch valued at about $8\frac{1}{2}$ million. The state's fishermen catch about 25 million pounds (11.4 million kilograms) of seafood annually. South Carolina ranks high among the states in shrimp caught. Other valuable catches include catfish, clams, crabs, oysters, and sea bass.

Electric Power. Steam-generating plants produce over four-fifths of South Carolina's electric power. Most of the rest comes from hydroelectric plants. In 1953, the Atomic Energy Commission's Savannah River Plant near Aiken began operating. Scientists there test ways of using nuclear energy to produce electricity. An experimental atomic energy plant in Parr produced electricity for privately owned public utility companies of South Carolina, North Carolina, and Virginia until it closed in 1967.

Transportation. South Carolina has about 60,000 miles (97,000 kilometers) of roads and highways, about two-thirds of which are surfaced. Railroads operate on about 3,000 miles (4,800 kilometers) of track in the state. Eleven railroads provide freight service, and passenger trains serve five South Carolina cities. The state has about 115 airports and 3 seaports—Charleston, Georgetown, and Port Royal. The Atlantic Intracoastal Waterway is South Carolina's chief inland shipping route (see ATLANTIC INTRACOASTAL WATERWAY).

Communication. More than 15 daily newspapers and about 80 semiweeklies and weeklies are published in South Carolina. The *South Carolina Weekly Journal*, the state's first newspaper, was published for only six months, sometime between 1730 and 1732. Today, the state's largest daily newspapers include the *Anderson Independent*, the *Greenville News*, the *News and Courier* of Charleston, and the *State* of Columbia.

South Carolina's first radio station, WSPA, began broadcasting in Spartanburg in 1930. The first television station, WCOS-TV, opened in Columbia in 1953. Today, the state has about 140 radio stations and 16 TV stations.

Indian Days. More than 30 Indian tribes lived in what is now South Carolina before the white man came. The chief tribes were the Catawba, the Cherokee, and the Yamasee (or Yemasee). The Catawba belonged to the Siouan Indian language family, the Cherokee to the Iroquoian language family, and the Yamasee to the Muskhogean language family. The Indians lived in semipermanent log shelters. Most of them raised crops.

Exploration and Settlement. In 1521, Francisco Gordillo led a Spanish expedition that explored the Carolina coast. Gordillo came from Spanish-held Santo Domingo in the Dominican Republic. In 1526, Lucas Vásquez de Ayllón, a judge from Santo Domingo Island, tried to establish a colony in what is now South Carolina. He led about 500 men, women, and children from Santo Domingo to the Winyah Bay region. But the colony failed because of disease and bad weather, and the settlers soon returned to Santo Domingo. Between 1562 and 1565, French explorers tried to settle at Port Royal and at another place farther south. They failed, partly because they lacked food.

England claimed the entire North American mainland in the early 1600's. The English based their claim on John Cabot's voyage to America in 1497 (see CABOT). In 1629, King Charles I of England granted North American land to Sir Robert Heath. Part of the grant was a strip of land that included what are now the states of South Carolina and North Carolina. The strip extended to the Pacific Ocean. The land was named *Province of Carolana* (land of Charles). The spelling was changed to *Carolina* in 1663. Heath made no attempts

IMPORTANT DATES IN SOUTH CAROLINA

1521 Francisco Gordillo of Spain explored the Carolina coast.

1526 Lucas Vásquez de Ayllón established a temporary settlement at Winyah Bay.

1670 Englishmen established the first permanent white settlement in South Carolina, at Albemarle Point.

1719 South Carolina became a separate royal province.

1780 American forces won the Battle of Kings Mountain, a turning point in the Revolutionary War.

1788 South Carolina became the 8th state on May 23.

1832 South Carolina passed the Ordinance of Nullification.

1860 South Carolina seceded from the Union on Dec. 20.

1861 The Civil War began on April 12 when Confederate forces fired on Fort Sumter.

1868 South Carolina was readmitted to the Union on June 25.

1877 Reconstruction ended in South Carolina.

1890 Benjamin Tillman, a leader of small farmers, became governor.

1895 South Carolina adopted its present constitution.

1941 The Santee-Cooper Project was completed.

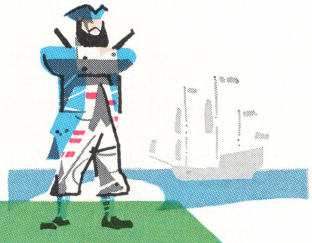
1953 Operations began at the Atomic Energy Commission's Savannah River Plant near Aiken. The plant produces nuclear materials.

1964 South Carolina voted for Barry M. Goldwater, the first Republican presidential candidate to carry the state since the Reconstruction. Senator Strom Thurmond resigned from the Democratic Party and became a Republican.

1970 Three Negroes won election to the state legislature. They became the first blacks elected to the General Assembly since 1900.

HISTORIC SOUTH CAROLINA

Battle of Kings Mountain, in which the British were defeated, was fought Oct. 7, 1780. It was the turning point of the Revolutionary War in the South.

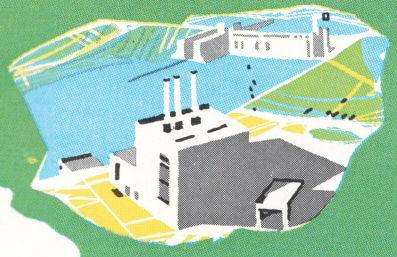


Blackbeard and other pirates preyed along the South Carolina coast in the early 1700's. Many were hanged from the gallows on Charleston's Execution Dock.

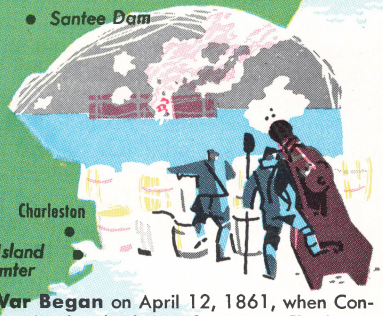
Rice Was First Raised successfully in North America near Charleston about 1685 by H. H. Woodward, from seed given to him by a ship's captain.

COLUMBIA ★

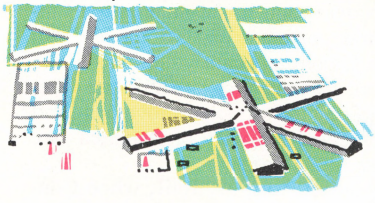
Santee Dam, completed in 1941, harnessed the Santee River to provide hydroelectric power. The dam also made an abandoned canal navigable.



• *Santee Dam*



Savannah River Plant near Aiken makes nuclear materials. The plant uses about 750,000 gallons (2,840,000 liters) of water daily.



Charleston •

James Island
Fort Sumter

The Civil War Began on April 12, 1861, when Confederate batteries bombed Fort Sumter in Charleston Harbor. Federal troops evacuated the fort on April 14.

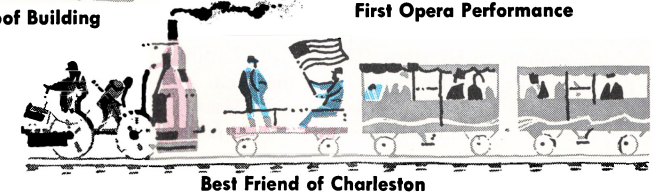
Charleston Water Front in 1760

One of the Nation's First Museums

First Fireproof Building

First Theater
First Opera Performance

Charleston's Early Achievements include one of the first museums, founded in 1773; the first fireproof structure, built in 1822; the first opera performance, given about 1702; and the first steam engine in service, in 1830.



Best Friend of Charleston

to establish settlements in the area of Carolina.

In 1663, King Charles II granted Carolina to eight English noblemen called *lords proprietors*. In 1670, the proprietors sent settlers to America. The settlers established South Carolina's first permanent white settlement at Albemarle Point, near what is now Charleston. The colonists moved to Oyster Point in 1680, and named the settlement Charles Town. The spelling was changed to *Charleston* in 1783.

Colonial Days. The proprietors wanted to limit self-government in Carolina. They also failed to protect the settlers when enemies threatened the colony. During Queen Anne's War (1702-1713), the colonists turned back French and Spanish forces at Charleston. They successfully defended themselves against attacks by the Yamasee Indians and against several pirate raids between 1715 and 1718. During these battles, the colonists received little help from the powerful proprietors. In 1719, the proprietors rejected laws requested by the colonists. As a result, the colonists rebelled against the proprietors that same year.

The South Carolina region was Great Britain's southern line of defense against French and Spanish attacks. Partly for this reason, King George I bought the South Carolina region from the proprietors in 1719, and made it a royal colony. Britain ruled the colony, but the people were allowed self-government. In 1729, the king bought the North Carolina region, and in 1730 he divided Carolina into two royal provinces—South Carolina and North Carolina. In 1732, the southern part of South Carolina became the colony of Georgia.

During the mid-1700's, many South Carolinians moved from coastal settlements to the Up Country. The Up Country population was also increased by waves of settlers from Pennsylvania and Virginia. By 1775, about 70,000 white persons and about 100,000 Negroes lived in South Carolina. Most of the Negroes were slaves.

The Revolutionary War. During the 1760's, Great Britain passed a series of laws that caused unrest in South Carolina and the other American colonies. Most of these laws set up new taxes or restricted colonial trade. Some South Carolinians, called *Tories*, urged loyalty to Britain in spite of the laws. But the majority of the people, called *Whigs*, favored independence.

The Revolutionary War began in Massachusetts in 1775. South Carolina became the scene of many important battles. In June, 1776, British land and sea forces tried to capture Charleston. But the colonists defeated the British in the Battle of Fort Moultrie. A second British attack on Charleston was turned back in 1779. The British finally captured the city in 1780. In August of that year, the British defeated colonial troops under General Horatio Gates at Camden. The British and their Tory allies then controlled most of South Carolina. Colonial victories in the Battle of Kings Mountain (Oct. 7, 1780) and at Cowpens (Jan. 17, 1781) turned the tide of war in the South. In 1781, colonial troops under General Nathanael Greene drove the main British army from South Carolina to Virginia. The South Carolina militia forced smaller British units from the area. Famous leaders of the militia included Francis Marion, called the *Swamp Fox;* Thomas Sumter, called the *Gamecock;* and Andrew Pickens. The British evacuated Charleston in 1782. During the war, 137 battles or smaller fights took place in South Carolina. Most of them were fought between bands of Whigs and Tories.

On July 9, 1778, South Carolina *ratified* (approved) the Articles of Confederation, the forerunner of the United States Constitution. South Carolina became the eighth state of the Union on May 23, 1788, when it ratified the U.S. Constitution.

Nullification. South Carolina strongly supported state's rights and free trade. The state's people opposed federal tariffs because South Carolina's economy depended heavily on trade with European nations. Tariffs, of course, discouraged this trade. A depression hit the United States in 1819, and South Carolinians blamed federal tariffs for their economic problems. In 1828, Congress passed a law that raised tariffs even higher than before. This law was called the "tariff of abominations." Reaction against the federal government spread throughout the state. In 1828, Vice-President John C. Calhoun, a South Carolinian, wrote the *Exposition and Protest.* This document declared that no state was bound by a federal law which the state regarded as unconstitutional. After another high tariff law was passed in 1832, South Carolina adopted an *Ordinance of Nullification.* This ordinance declared the tariff acts of 1828 and 1832 "null and void." President Andrew Jackson threatened to send troops to South Carolina to enforce the law. But Congress passed a compromise tariff bill in 1833, and South Carolina repealed the Ordinance of Nullification. See NULLIFICATION.

The Civil War. Shortly after the nullification crisis, an antislavery movement gained strength in the North. In 1850, a dispute between the North and South arose over whether slavery should be allowed in parts of the West. South Carolina threatened to *secede* (withdraw) from the Union. But little support came from other Southern states, and South Carolina took no further action. On Nov. 6, 1860, Abraham Lincoln, a Northern Republican, was elected President. South Carolina feared Lincoln would use federal power to abolish slavery. On Dec. 20, 1860, South Carolina became the first state to secede from the Union. By the spring of 1861, ten other Southern states had joined the secession movement and had formed the Confederate States of America (see CONFEDERATE STATES OF AMERICA).

The Civil War began on April 12, 1861, when Confederate troops fired on Fort Sumter in Charleston Harbor. Fighting raged along the South Carolina coast throughout the war. A blockade of Charleston Harbor by the Union fleet ruined South Carolina's economy. In 1865, Union troops led by William T. Sherman destroyed many plantations in the state. They also burned Columbia, the capital. About a fourth of the 63,000 troops from South Carolina died during the war.

Reconstruction. During the Reconstruction period after the Civil War, Union troops occupied South Carolina and the other Southern states. The Republican party in the state was made up chiefly of Negroes, southern Union sympathizers called *scalawags*, and northern adventurers called *carpetbaggers*. The Republicans controlled the South Carolina government during part of the Reconstruction period, and had the support of the Union troops. In 1868, South Carolina adopted a new state constitution. The new constitution gave Negroes

the right to vote. Congress readmitted South Carolina to the Union on June 25, 1868.

In 1876, Wade Hampton, a Democrat and a Confederate cavalry hero, defeated the Republican candidate for governor. The Republicans challenged the election results, and South Carolina had rival state governments for several months. President Rutherford B. Hayes withdrew the federal troops from South Carolina in March, 1877. Republican power then collapsed, and the Democrats gained control of the state.

Industrial Growth began in South Carolina during the late 1800's. Profits from agriculture had declined greatly after the Civil War. The decline was caused chiefly by competition from many new farms in the western United States. About 1880, South Carolina businessmen began expanding the textile industry. Hydroelectric power, rather than direct water power, became the source of energy for many textile mills. Thousands of poor farmers welcomed the chance to work in the textile mills, even at low wages. A number of textile companies moved from Northern states to South Carolina, partly to take advantage of this inexpensive labor.

During the late 1800's, a group of Democrats called *Tillmanites* gained control of South Carolina politics. The group was led by Benjamin R. Tillman. Before 1890, a group called the Bourbon Democrats ran South Carolina politics. The Bourbon Democrats were lawyers, planters, and businessmen whose strength was in the Low Country. Owners of small farms, especially those in the Up Country, protested the Bourbon rule after farm prices dropped. Tillman campaigned for widespread reforms in state government, and was elected governor in 1890. The Tillmanites rewrote the state Constitution, and all but eliminated Negro voting rights. Tillman became a U.S. senator in 1895, and remained a powerful force in South Carolina politics until his death in 1918.

After the United States entered World War I in 1917, South Carolina's textile mills produced large quantities of cloth for the armed forces. By 1920, the state's textile industry employed about 54,600 workers and was still growing.

THE GOVERNORS OF SOUTH CAROLINA

	Party	Term
Under the Articles of Confederation		
1. John Rutledge	None	1779-1782
2. John Mathews	None	1782-1783
3. Benjamin Guerard	None	1783-1785
4. William Moultrie	None	1785-1787
5. Thomas Pinckney	None	1787-1789
Under the United States Constitution		
1. Thomas Pinckney	None	1787-1789
2. Charles Pinckney	None	1789-1792
3. William Moultrie	Federalist	1792-1794
4. Arnoldus Vander Horst	Federalist	1794-1796
5. Charles Pinckney	*Dem.-Rep.	1796-1798
6. Edward Rutledge	Dem.-Rep.	1798-1800
7. John Drayton	Dem.-Rep.	1800-1802
8. James B. Richardson	Dem.-Rep.	1802-1804
9. Paul Hamilton	Dem.-Rep.	1804-1806
10. Charles Pinckney	Dem.-Rep.	1806-1808
11. John Drayton	Dem.-Rep.	1808-1810
12. Henry Middleton	Dem.-Rep.	1810-1812
13. Joseph Alston	Dem.-Rep.	1812-1814
14. David R. Williams	Dem.-Rep.	1814-1816
15. Andrew Pickens	Dem.-Rep.	1816-1818
16. John Geddes	Dem.-Rep.	1818-1820
17. Thomas Bennett	Dem.-Rep.	1820-1822
18. John L. Wilson	Dem.-Rep.	1822-1824
19. Richard I. Manning	Dem.-Rep.	1824-1826
20. John Taylor	Dem.-Rep.	1826-1828
21. Stephen D. Miller	Democratic	1828-1830
22. James Hamilton, Jr.	Democratic	1830-1832
23. Robert Y. Hayne	Democratic	1832-1834
24. George McDuffie	Democratic	1834-1836
25. Pierce M. Butler	Democratic	1836-1838
26. Patrick Noble	Democratic	1838-1840
27. B. K. Henagan	Democratic	1840
28. John P. Richardson	Democratic	1840-1842
29. James H. Hammond	Democratic	1842-1844
30. William Aiken	Democratic	1844-1846
31. David Johnson	Democratic	1846-1848
32. Whitemarsh B. Seabrook	Democratic	1848-1850
33. John H. Means	Democratic	1850-1852
34. John L. Manning	Democratic	1852-1854
35. James H. Adams	Democratic	1854-1856
36. Robert F. W. Allston	Democratic	1856-1858
37. William H. Gist	Democratic	1858-1860
38. Francis W. Pickens	Democratic	1860-1862
39. Milledge L. Bonham	Democratic	1862-1864
40. Andrew G. Magrath	Democratic	1864-1865
41. Benjamin F. Perry	Democratic	1865
42. James L. Orr	Democratic	1865-1868
43. Robert K. Scott	Republican	1868-1872
44. Franklin J. Moses, Jr.	Republican	1872-1874
45. Daniel H. Chamberlain	Republican	1874-1876
46. Wade Hampton	Democratic	1876-1879
47. William D. Simpson	Democratic	1879-1880
48. Thomas B. Jeter	Democratic	1880
49. Johnson Hagood	Democratic	1880-1882
50. Hugh S. Thompson	Democratic	1882-1886
51. John C. Sheppard	Democratic	1886
52. John P. Richardson	Democratic	1886-1890
53. Benjamin R. Tillman	Democratic	1890-1894
54. John G. Evans	Democratic	1894-1897
55. William H. Ellerbe	Democratic	1897-1899
56. Miles B. McSweeney	Democratic	1899-1903
57. Duncan C. Heyward	Democratic	1903-1907
58. Martin F. Ansel	Democratic	1907-1911
59. Coleman L. Blease	Democratic	1911-1915
60. Charles A. Smith	Democratic	1915
61. Richard I. Manning	Democratic	1915-1919
62. Robert A. Cooper	Democratic	1919-1922
63. Wilson G. Harvey	Democratic	1922-1923
64. Thomas G. McLeod	Democratic	1923-1927
65. John G. Richards	Democratic	1927-1931
66. Ibra C. Blackwood	Democratic	1931-1935
67. Olin D. Johnston	Democratic	1935-1939
68. Burnet R. Maybank	Democratic	1939-1941
69. J. Emile Harley	Democratic	1941-1942
70. Richard M. Jefferies	Democratic	1942-1943
71. Olin D. Johnston	Democratic	1943-1945
72. Ransome J. Williams	Democratic	1945-1947
73. Strom Thurmond	Democratic	1947-1951
74. James F. Byrnes	Democratic	1951-1955
75. George B. Timmerman, Jr.	Democratic	1955-1959
76. Ernest F. Hollings	Democratic	1959-1963
77. Donald S. Russell	Democratic	1963-1965
78. Robert E. McNair	Democratic	1965-1971
79. John C. West	Democratic	1971-1975
80. James B. Edwards	Republican	1975-

*Democratic-Republican

Nylon Industries, Inc.

Huge Nylon Manufacturing Plant was built in Greenville in 1963. Industry expanded in South Carolina after World War II. Today, almost every county has one or more factories built since 1945.

The boll weevil damaged much cotton in South Carolina during the 1920's. Many farmers began raising other crops, including fruits, tobacco, and wheat. But cotton remained the main farm product. The Great Depression of the 1930's caused widespread unemployment in South Carolina. Economic conditions improved as the depression eased in the late 1930's.

The Mid-1900's brought great economic growth to South Carolina as the state shifted from a chiefly agricultural to a more industrial economy. In 1941, the South Carolina Public Service Authority completed the Santee-Cooper navigational canal and power dam between the Santee and Cooper rivers. This $57-million project supplied electric power and helped industry (see SANTEE-COOPER PROJECT). During World War II (1939-1945), many military bases were established in the state. Some of the bases were made permanent after the war.

In 1953, operations began at the $1,400,000,000 Savannah River Plant of the Atomic Energy Commission (now the Energy and Research Development Administration) near Aiken. This plant helped South Carolina become a leader in the production of nuclear materials.

During the 1960's, South Carolina industry continued to expand, largely through programs sponsored by the State Development Board. Various companies built manufacturing facilities worth nearly $4 billion.

In the mid-1900's, the Democratic Party lost much of its traditional control of South Carolina politics. In 1948, Governor Strom Thurmond of South Carolina was nominated for President by the States' Rights Democratic (Dixiecrat) Party. Thurmond received the electoral votes of four states—Alabama, Louisiana, Mississippi, and South Carolina. In the 1952, 1956, and 1960 presidential elections, the Democrats barely won South Carolina. Then, in 1964, the state's electoral votes went to the Republican candidate, Barry M. Goldwater, by a large majority. The state also supported Republican Richard M. Nixon for President in 1968. Thurmond, who had been elected to the U.S. Senate in 1954, resigned from the Democratic Party in 1964 and became a Republican. In the mid-1900's, several Republicans were elected to the state legislature and some were elected mayors and city councilmen.

Since the late 1940's, South Carolina Negroes had been voting in growing numbers. They increased their efforts in both voter registration and voting in elections of the 1960's. Negroes were elected to several local offices, including city councilman and school trustee. In 1970, three blacks won election to the state legislature, becoming the first Negroes elected to the General Assembly since 1900.

South Carolina schools changed greatly following the 1954 decision of the Supreme Court of the United States prohibiting compulsory school segregation. Traditionally, the state had operated separate schools for Negroes and whites. In the 1960's, most of South Carolina's school districts became integrated.

South Carolina Today is encouraging further industrial growth. At the same time, the state has become increasingly concerned about air and water pollution. Pollution has caused special concern where industry is in or near recreation and historic areas.

Tobacco remains South Carolina's chief crop. But criticism that cigarette smoking is harmful to health threatens to reduce income from tobacco. As a result, tobacco farmers are looking for substitute crops. In education, the state faces the problem in the 1970's of expanding its colleges and universities so they can handle the increasing numbers of people who want college training. South Carolina is also testing a program that provides state support for kindergartens.

Negroes and white Republicans continue to take a larger role in South Carolina politics. Some Negroes pushed ahead with plans to form a basically black political party. Republicans planned to run candidates for offices traditionally held by Democrats without opposition. In 1972, Nixon carried South Carolina again and Thurmond won re-election. In 1974, James B. Edwards became the first Republican to be elected governor of the state in 100 years.

DONALD O. BUSHMAN, ERNEST M. LANDER, JR., and WILLIAM D. WORKMAN, JR.

SOUTH CAROLINA / *Study Aids*

Related Articles in WORLD BOOK include:

BIOGRAPHIES

Allston, Washington
Butler, Pierce
Byrnes, James F.
Calhoun, John C.
Gadsden (family)
Grimké (family)
Hampton, Wade
Hayne, Robert Y.
Heyward, Du Bose
Heyward, Thomas, Jr.
Jackson, Andrew
Longstreet, James
Lynch, Thomas, Jr.
Marion, Francis
Middleton, Arthur
Moultrie, William
Pinckney (family)
Pinckney, Charles
Rutledge (family)
Smalls, Robert
Thurmond, Strom
Vesey, Denmark
Watson, John B.
Westmoreland, William Childs

CITIES

Beaufort, Charleston, Columbia, Greenville, Spartanburg, Sumter

HISTORY

Civil War, Confederate States of America, Fort Moultrie, Fort Sumter, Nullification, Reconstruction, Revolutionary War in America

PHYSICAL FEATURES

Atlantic Intracoastal Waterway, Blue Ridge Mountains, Pee Dee River, Piedmont Region, Saluda Dam, Savannah River

PRODUCTS

For South Carolina's rank among the states in production, see the following articles:
Peach, Textile, Tobacco

OTHER RELATED ARTICLES

Charleston Naval Base, Fort Sumter National Monument, Parris Island Marine Corps Recruit Depot, Santee-Cooper Project, Southern States

Outline

I. Government
- A. Constitution
- B. Executive
- C. Legislature
- D. Courts
- E. Local Government
- F. Taxation
- G. Politics

II. People

III. Education
- A. Schools
- B. Libraries
- C. Museums

IV. A Visitor's Guide
- A. Places to Visit
- B. Annual Events

V. The Land
- A. Land Regions
- B. Coastline
- C. Rivers, Waterfalls, and Lakes

VI. Climate

VII. Economy
- A. Natural Resources
- B. Manufacturing
- C. Agriculture
- D. Mining
- E. Fishing Industry
- F. Electric Power
- G. Transportation
- H. Communication

VIII. History

Questions

What percentage of South Carolina's people live in rural areas?

Where did the Civil War begin?

Who have been the only non-Democratic presidential candidates to win South Carolina's electoral votes since Reconstruction?

What two groups began to take a larger role in South Carolina politics during the mid-1900's?

What school built the first separate college library building in the United States?

When was the Santee-Cooper Project completed?

Who were the *lords proprietors?*

What is South Carolina's chief economic activity?

What South Carolina garden has been called "the most beautiful in the world"?

What are the three main land regions in South Carolina?

Books for Young Readers

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CARPENTER, ALLAN. *South Carolina.* Childrens Press, 1967.

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HENNIG, HELEN K. *Great South Carolinians.* 2 vols. Books for Libraries, 1940.

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SLOAN, EUGENE B. *Scenic South Carolina.* 2nd ed. Lewis-Sloan Pub. Co., 1971.

STEEDMAN, MARGUERITE C. *The South Carolina Colony.* Macmillan, 1970.

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Books for Older Readers

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LANDER, ERNEST M. *A History of South Carolina, 1865-1960.* 2nd ed. Univ. of South Carolina Press, 1970.

RUTLEDGE, ARCHIBALD. *Home by the River.* Sandlapper Press, 1941.

WALLACE, DAVID D. *South Carolina: A Short History, 1520-1948.* Univ. of South Carolina Press, 1961.

SOUTH CAROLINA, UNIVERSITY OF, is a state-controlled coeducational school in Columbia, S.C. It has colleges of arts and science, business administration, education, engineering, general studies, journalism, nursing, and pharmacy. It also has a graduate school and schools of law, library science, and social work. The university grants bachelor's, master's, and doctor's degrees. It operates two-year branch campuses in Aiken, Allendale, Beaufort, Conway, Lancaster, Spartanburg, and Union.

In 1801, the school was chartered as South Carolina College. It is one of the oldest state-supported schools in the United States. Its library building has the largest and most valuable collection of South Carolina historical material in existence. For enrollment, see UNIVERSITIES AND COLLEGES (table). WILLIAM H. PATTERSON

SOUTH CAROLINA STATE COLLEGE is a coeducational college in Orangeburg, S.C. It has schools of arts and sciences, education, home economics, industrial education and engineering technology, and graduate studies. Courses at the college lead to bachelor's and master's degrees.

South Carolina State has cooperative education programs in agriculture and nursing with Clemson University. The college library has a special collection of material written about the American Negro. South Carolina State College was founded in 1896, and took its present name in 1954. For enrollment, see UNIVERSITIES AND COLLEGES (table). M. MACEO NANCE, JR.

SOUTH CENTRAL STATES. See SOUTHERN STATES; ALABAMA; ARKANSAS; KENTUCKY; LOUISIANA; MISSISSIPPI; OKLAHOMA; TENNESSEE; TEXAS.

South Dakota Dept. of Highways

Tending Cattle on the Plains of South Dakota

SOUTH DAKOTA

The Sunshine State

SOUTH DAKOTA is a midwestern state of many startling and beautiful contrasts. The wide Missouri River flows southward through the middle of the state. Low hills, lakes formed by ancient glaciers, and vast stretches of fertile cropland lie east of the river. West of the river are deep canyons and rolling plains. The enchanting Black Hills rise abruptly in the southwest. Southeast of the Black Hills are the weirdly beautiful Badlands. South Dakota is often called the *Land of Infinite Variety* because of the many great differences in its landscape.

South Dakota is mainly a farm state. Farms and ranches cover about nine-tenths of the state. Sheep and cattle graze on the sprawling ranches of the western plains, and on smaller farms in the east. Crops are grown on the rich soil of eastern South Dakota. The state is a major producer of beef cattle, hogs, and sheep. It also ranks high in growing corn, flaxseed, rye, spring wheat, and other crops.

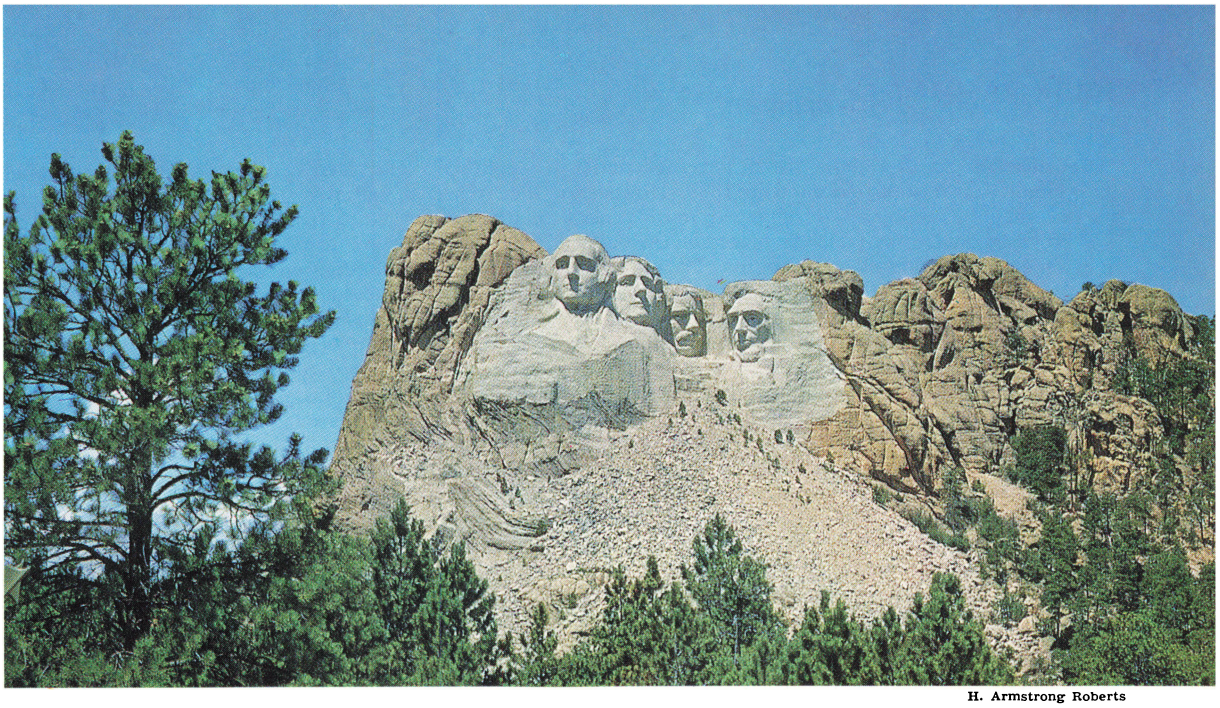
Millions of tourists visit South Dakota every year. The Black Hills are one of the nation's most popular vacationlands. Attractions there include Mount Rushmore National Memorial, also called the *Shrine of Democracy*. Heads of George Washington, Thomas Jefferson, Theodore Roosevelt, and Abraham Lincoln, 60 feet (18 meters) high, have been carved out of a granite mountain. The memorial is one of the world's largest sculptures. Nearby, an even larger statue of the Sioux chief Crazy Horse is being blasted out of a mountain.

Most of South Dakota's mineral wealth lies in the Black Hills. Gold was discovered there in 1874. Two years later, the rich Homestake *lode* (deposit) was discovered. The Homestake Mine is still the greatest gold producer in the Western Hemisphere.

The history of South Dakota reads like an adventure story. It is a tale of daring fur traders, battles between Indians and white settlers, and stampedes for gold. Included in the story of South Dakota's development are such colorful names as Calamity Jane, George A. Custer, Sitting Bull, and Wild Bill Hickok. But the most important figure in the state's history has been the farmer. The courageous South Dakota farmer has clung to his land through droughts, depressions, and blizzards. He has made South Dakota one of the nation's great agricultural states.

South Dakota was named for the Sioux Indians who once roamed the region. The Sioux called themselves *Dakota* or *Lakota*, meaning *allies* or *friends*. South Dakota's sunny climate earned it the nickname of the *Sunshine State*. The many coyotes that once lived in South Dakota gave it another nickname, the *Coyote State*.

The geographic center of the United States is in South Dakota, 17 miles (27 kilometers) west of Castle Rock. Pierre is the capital of South Dakota, and Sioux Falls is the largest city. For the relationship of South Dakota to other states in its region, see MIDWESTERN STATES.



H. Armstrong Roberts

Mount Rushmore National Memorial near Rapid City

FACTS IN BRIEF

Capital: Pierre.

Government: *Congress*—U.S. senators, 2; U.S. representatives, 2. *Electoral Votes*—4. *State Legislature*—senators, 35; representatives, 70. *Counties*—67.

Area: 77,047 sq. mi. (199,551 km²), including 1,092 sq. mi. (2,828 km²) of inland water; 16th in size among the states. *Greatest Distances*—east-west, 380 mi. (612 km); north-south, 245 mi. (394 km).

Elevation: *Highest*—Harney Peak, 7,242 ft. (2,207 m) above sea level. *Lowest*—Big Stone Lake, 962 ft. (293 m) above sea level.

Population: *Estimated 1975 Population*—660,000; 44th among the states; distribution, 55 per cent rural, 45 per cent urban; density, 9 persons per sq. mi. (3 per km²). *1970 Census*—666,257.

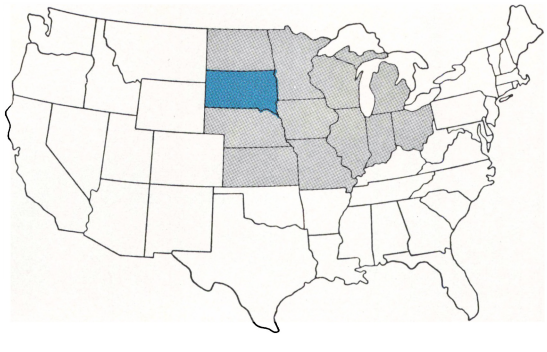
Chief Products: *Agriculture*—beef cattle, corn, eggs, flaxseed, hay, hogs, milk, oats, rye, sheep, soybeans, wheat. *Manufacturing*—food and food products; nonelectrical machinery; printed materials; stone, clay, and glass products. *Mining*—clay, gold, sand and gravel, stone.

Statehood: Nov. 2, 1889, the 40th state.

State Motto: *Under God the People Rule.*

State Song: "Hail, South Dakota." Words and music by Deecort Hammitt.

The contributors of this article are Duncan J. McGregor, State Geologist and Professor of Geology at the University of South Dakota; Everett W. Sterling, Professor of History at the University of South Dakota; and Anson Anders Yeager, Sr., Executive Editor of the Sioux Falls Argus-Leader.



South Dakota (blue) ranks 16th in size among all the states, and 4th in size among the Midwestern States (gray).

Days of '76 Parade in Deadwood

South Dakota Dept. of Highways

Constitution. South Dakota is still governed under its original Constitution, adopted in 1889. However, the document has been *amended* (changed) many times.

A proposed amendment must be placed on the ballot in a regular statewide election. It may be proposed and placed on the ballot in any of three ways: (1) The Legislature may propose it by a majority vote in each house. (2) A group of citizens may propose an amendment by *initiative*. In this method, the citizens submit a *petition* (formal request) signed by at least 10 per cent of the number of persons who voted in the last election for governor. (3) A constitutional convention, approved by a three-fourths majority vote in each house of the Legislature, may propose an amendment. To become law, an amendment must be approved by a majority of the citizens voting on the issue.

Executive. The governor of South Dakota is elected to a four-year term. He may not serve more than two terms in a row. The governor receives a yearly salary of $27,500. For a list of South Dakota's governors, see the *History* section of this article.

Other executive officials include the lieutenant governor, secretary of state, attorney general, commissioner of school and public lands, treasurer, and auditor. They are also elected to four-year terms. All may serve an unlimited number of terms.

Legislature consists of a 35-member senate and a 70-member house of representatives. Voters in 25 of the state's 28 legislative districts elect 1 senator and 2 representatives. Voters in the other 3 districts elect from 2 to 5 senators and from 4 to 10 representatives, depending on population. Members of both houses serve two-year terms. In even-numbered years, the Legislature meets on the Tuesday after the first Monday in January. In odd-numbered years, it meets on the Tuesday after the third Monday in January. Sessions last 30 days in even-numbered years and 45 days in odd-numbered years. The governor may call special sessions.

South Dakota voters can pass laws directly through their power of initiative. In 1898, South Dakota became the first state to adopt the initiative and referendum. If 5 per cent of the state's voters sign a petition for the adoption of a law, the Legislature must pass the measure. It is then put on a statewide ballot. The *referendum* allows voters to accept or reject measures approved by the Legislature. Any law passed by the Legislature must be submitted to the people if 5 per cent of the voters sign a petition asking that a vote on the law be taken. See INITIATIVE AND REFERENDUM.

Courts. The state supreme court is the highest court. It has five judges elected to eight-year terms. Each year, the judges select one of their number to be the chief justice. Voters in each of the 10 judicial districts elect at least two circuit court judges to eight-year terms. The number of judges depends on district population.

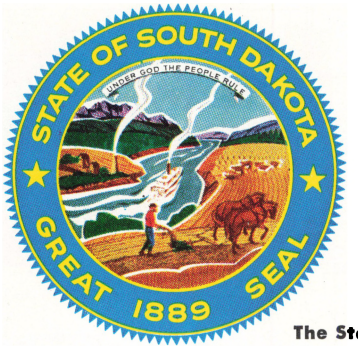
Local Government. South Dakota has 67 counties. Three of these counties—Shannon, Todd, and Washabaugh—do not have an organized county government. Their county functions are administered by adjoining counties. Each organized county is governed by a board of commissioners of three to five members elected to four-year terms. Other elected county officials include the attorney, auditor, clerk of courts, register of deeds, sheriff, and treasurer.

South Dakota has more than 300 cities and towns. The state constitution gives them the power of *home rule*. That is, cities and towns may operate under their own charters and adopt their own form of government. Most cities have the mayor-council form of government.

Taxation. Taxes and licenses bring in more than half of the state government's income. Almost all the rest comes from federal grants. Motor vehicle license fees, and taxes on sales and motor fuels provide most of the state's tax revenue. South Dakota also collects taxes on alcoholic beverages and tobacco. It does not tax property or personal incomes. Only banks and other financial institutions pay corporation taxes.

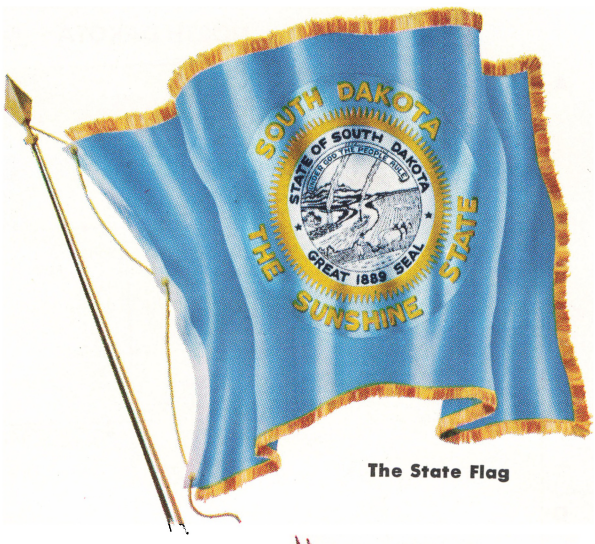
The Governor's Mansion is in Pierre. The house, surrounded by landscaped grounds, was built in 1936. A basement room serves as a museum of Indian relics.
South Dakota Dept. of Highways

"Great Seal of South Dakota"



The State Seal

Symbols of South Dakota. On the seal, the smelter chimney represents mining, the plowman stands for farming, and the riverboat symbolizes transportation. The seal was adopted in 1889. The state flag, adopted in 1963, has the seal in the center. The gold circle around the seal represents the blazing rays of the sun. The blue field symbolizes South Dakota's clear skies.

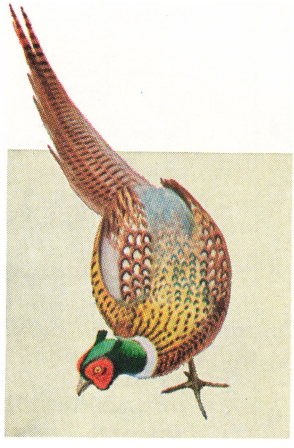


The State Flag

Flower illustration, courtesy of Eli Lilly and Company

Politics. South Dakota voters have strongly favored the Republican Party throughout most of the state's history. In 1889, the people elected a Republican as the first governor of their state. Since then, South Dakota has had only four Democratic governors. The state has voted for the Democratic presidential candidate in only four elections—1896, 1932, 1936, and 1964. For South Dakota's electoral votes and voting record in presidential elections, see ELECTORAL COLLEGE (table).

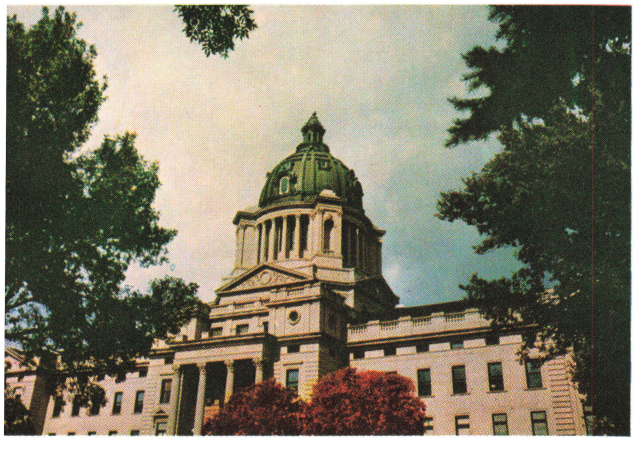
During the 1960's, South Dakota showed signs of becoming a two-party state. In 1962, for the first time since 1936, the state elected a Democrat, George McGovern, to the U.S. Senate. In the early 1970's, Democrats won most of the chief state offices, including the governorship. Also during this period, Democrats won election to additional South Dakota seats in the U.S. Senate and House of Representatives.



The State Bird
Ring-Necked Pheasant

The State Capitol stands near the Missouri River in Pierre. The limestone and white marble building was begun in 1905. Pierre has been South Dakota's capital since 1889. Earlier capitals were Yankton (1861-1883) and Bismarck, N. Dak. (1883-1889).

South Dakota Dept. of Highways



The State Flower
American Pasqueflower

The State Tree
Black Hills Spruce

SOUTH DAKOTA Political Map
State capital
County seat
Forest or other conservation area
Major airport
Highways:
Urban area in South Dakota
CLAY County name
Military or other federal area
Water
Expressway
Other road
Urban area outside South Dakota
County boundary
Indian reservation
River
Interstate
City or town
Park or other recreation area
Point of interest
Intermittent river
U. S.
Other
Lambert conformal conic projection
WORLD BOOK map ©Field Enterprises Educational Corporation
Distance scale
0 10 20 40 60 80 100 120 140 160 180
0 10 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300
NORTH DAKOTA
MONTANA
WYOMING
NEBRASKA
46° North Latitude
44° North Latitude
104° West Longitude
102° West Longitude
Rapid City
Deadwood
Lead
Spearfish
Sturgis
Belle Fourche
Newcastle
Custer
Hot Springs
Edgemont
Hettinger
Lemmon
Buffalo
Harding
Redig
Ladner
Ludlow
Camp Crook
Reva
Ralph
Lodgepole
White Butte
Shadehill
Bison
Meadow
Prairie City
Sorum
Chance
Zeona
Hoover
Castle Rock
Mud Butte
Maurine
Faith
Opal
Fairpoint
Stoneville
Redowl
Marcus
Howes
Plainview
Enning
Union Center
White Owl
Red Scaffold
Cherry Creek
Mission Ridge
Okoboji
Kirley
Milesville
Hereford
Bear Butte
Whitewood
Central City
Terraville
Tilford
Piedmont
Elm Springs
Creighton
Nemo
Black Hawk
Ellsworth Air Force Base
Villa Ranchero
Rochford
Silver City
Box Elder
Deerfield
Mystic
Redfern
New Underwood
Wasta
Owanka
Farmingdale
Hill City
Keystone
Rockerville
Hayward
Hermosa
Caputa
Pennington
Wall
Quinn
Cottonwood
Midland
Capa
Van Metre
Fort Pierre
Wendte
Ottumwa
Nowlin
Stamford
Belvidere
Kadoka
Okaton
Murdo
Draper
Vivian
Jones
Westover
Weta
Cedar Pass
Interior
Seven Mile Corner
Scenic
Fairburn
Pringle
Argyle
Dewey
Burdock
Minnekahta
Oral
Buffalo Gap
Red Shirt
Potato Creek
Wanblee
Cedar Butte
Mellette
White River
Wood
Mosher
Washabaugh
Unorganized. Attached to Jackson County.
Longvalley
Norris
Hisle
Kyle
Smithwick
Igloo
Provo
Rumford
Ardmore
Oelrichs
Manderson
Porcupine
Oglala
Wounded Knee
Slim Butte
Denby
Batesland
Pine Ridge
Shannon
Unorganized. Attached to Fall River County.
Fall River
Blackpipe
Allen
Patricia
Bennett
Swett
Martin
Tuthill
Harrington
Vetal
Parmelee
Rosebud
Okreek
Mission
Todd
Unorganized. Attached to Tripp County
Hidden Timber
Rosebud Indian Reservation
Saint Francis
Lakeview
Olsonville
Lacreek National Wildlife Refuge
Valentine
Snake River
North Loup River
Standing Rock
Bullhead
Mcintosh
Watauga
Keldron
Morristown
Thunder Hawk
Walker
Kenel
Pollock
Pocasse National Wildlife Refuge
McLaughlin
Mahto
Little Eagle
Wakpala
Corson
Indian Reservation
Mobridge
Glenham
Glad Valley
Firesteel
Glencross
Trail City
Timber Lake
Isabel
Whitehorse
Promise
Cheyenne River
Indian Reservation
La Plant
Ridgeview
Parade
Dewey
Eagle Butte
Lantry
Dupree
Ziebach
Thunder Butte
Redelm
Oahe Reservoir
Oahe Dam
Pierre
Hayes
Stanley
Haakon
Jackson
Philip
Buffalo Gap National Grasslands
Fort Pierre National Grassland
Badlands National Monument
Custer National Forest
Grand River National Grassland
Shadehill Reservoir
Pactola Reservoir
Angostura Reservoir
Belle Fourche Reservoir
Jewel Cave National Monument
Wind Cave National Park
Mount Rushmore National Memorial
Crazy Horse Memorial
Fossil Cycad National Monument
Black Hills National Forest
Black Hills
Lawrence
Meade
Butte
Perkins
Harding
Custer
Fall River
Bear Butte National Wildlife Refuge
Homestake Gold Mine
Jorman Dam
Geographic Center of the United States
Little Missouri River
Belle Fourche River
Cheyenne River
White River
Moreau River
Grand River
Cedar Creek
Boxelder Creek
Antelope Creek
Rabbit Creek
Thunder Butte Creek
Cherry Creek
Plum Creek
Oak Creek
Bad River
Elk Creek
Spring Creek
Rapid Creek
Battle Creek
Hat Creek
Angostura Reservoir
Pass Creek
Wounded Knee Creek

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NORTH DAKOTA
MINNESOTA
IOWA
NEBRASKA
Aberdeen
Sioux Falls
Watertown
Brookings
Huron
Mitchell
Madison
Yankton
Vermillion
Sioux City
Pierre
Lake Sharpe
Lake Francis Case
Lewis and Clark Lake
Missouri River
Big Sioux River
Lake Traverse
Big Stone Lake
Lake Benton
Lake Hendricks
Lake Poinsett
Lake Preston
Lake Madison
Lake Andes
Fort Randall Dam
Gavins Point Dam
Lake Andes National Wildlife Refuge
Sand Lake National Wildlife Refuge
Waubay National Wildlife Refuge
Houghton Dam
Corn Palace
Lake Andes
Wagner
Scotland
Tyndall
Springfield
Running Water
Bon Homme Colony
Hutterite Colony
Rosedale Colony
Elm Springs Colony
Wolf Creek Colony
Maxwell Colony
Rockport Colony
Stanley Corner
Bridgewater Corner
Ellis
Valley Springs
Rowena
East Sioux Falls
Shindler
Harrisburg
Worthing
Canton
Fairview
Rock Valley
Beresford
Alcester
Hawarden
Big Springs
Alsen
Nora
Spink
Junction City
Akron
Richland
Elk Point
Jefferson
North Sioux City
Burbank
Meckling
Gayville
Volin
Mission Hill
Wakonda
Irene
Centerville
Hudson
Viborg
Hooker
Center Point
Davis
Hurley
Menno
Olivet
Tripp
Delmont
Armour
Geddes
Platte
Winner
Gregory
Burke
Colome
Clearfield
Keyapaha
Millboro
Wewela
Herrick
Paxton
Saint Charles
Bonesteel
Fairfax
Fort Randall
Pickstown
Ravinia
Dante
Avon
Marty
Greenwood
Perkins
Bassett
Ainsworth
O'Neill
Elkhorn River
Niobrara River
Ponca Creek
Keya Paha River
Wayne
Hartington
Lesterville
Mayfield
Utica
Tabor
Yankton
Springfield
Vermillion
Burbank
Richland
Elk Point
Jefferson
North Sioux City
Sioux City
Wayne
Logan Creek
Big Sioux River
Missouri River
Vermillion River
Turkey Ridge Creek
Emanuel Creek
Choteau Creek
Platte Creek
Ponca Creek
Keya Paha River
Niobrara River
Elkhorn River

SOUTH DAKOTA MAP INDEX

Population

660,000 ..Estimate..1975
666,257 ..Census...1970
680,514 .....".....1960
652,740 .....".....1950
642,961 .....".....1940
692,849 .....".....1930
636,547 .....".....1920
583,888 .....".....1910
401,570 .....".....1900
348,600 .....".....1890
98,268 .....".....1880
11,776 .....".....1870

Metropolitan Area

Sioux Falls 95,209

Counties

Aurora .....4,183..G 12
Beadle ....20,877..E 12
Bennett ....3,088..H 5
Bon Homme .8,577..I 13
Brookings ..22,158..E 15
Brown .....36,920..B 12
Brule .....5,870..G 11
Buffalo .....1,739..F 10
Butte .....7,825..D 2
Campbell ....2,866..B 9
Charles Mix 9,994..H 11
Clark .....5,515..D 13
Clay .....12,923..I 15
Codington ..19,140..C 14
Corson .....4,994..B 6
Custer .....4,698..G 2
Davison ...17,319..G 13
Day .....8,713..C 14
Deuel .....5,686..D 15
Dewey .....5,170..C 8
Douglas ....4,569..H 12
Edmunds ...5,548..B 10
Fall River ..7,505..H 2
Faulk .....3,893..C 11
Grant .....9,005..C 16
Gregory ....6,710..H 11
Haakon .....2,802..E 6
Hamlin .....5,520..D 15
Hand .....5,883..E 11
Hanson .....3,781..G 13
Harding ....1,855..B 2
Hughes ....11,632..E 9
Hutchinson 10,379..H 13
Hyde .....2,515..E 10
Jackson .....1,531..G 6
Jerauld .....3,310..F 12
Jones .....1,882..F 8
Kingsbury ..7,657..E 14
Lake .....11,456..F 15
Lawrence ..17,453..E 1
Lincoln ....11,761..H 16
Lyman .....4,060..F 9
Marshall ....5,965..A 14
McCook .....7,246..G 14
McPherson ...5,022..A 10
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Potter .....4,449..C 9
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Shannon ....8,198..H 3
Spink .....10,595..D 12
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Sully .....2,362..D 9
Todd .....6,606..H 7
Tripp .....8,171..H 9
Turner .....9,872..H 15
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Walworth ...7,842..B 9
Washabaugh 1,389..G 6
Yankton ...19,039..I 14
Ziebach .....2,221..D 6

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Academy .....H 11
Agar .....156..D 9
Akaska .....46..C 9
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Alcester .....627..I 16
Alexandria ...598.°G 14
Allen .....H 5
Alpena .....307..F 12
Altamont .....54..D 16
Amherst .....A 13
Andover .....138..B 13
Ardmore .....14..I 2
Arlington .....954..E 15
Armour .....925.°H 12
Artas .....73..A 9
Artesian .....277..F 13
Ashton .....137..C 12
Astoria .....153..E 16
Athol .....C 12
Aurora .....237..E 16
Avon .....610..I 13
Badger .....122..E 15
Baltic .....364..G 16
Bancroft .....48..E 14
Barnard .....A 12
Batesland ....135..I 5
Bath .....B 12
Belle Fourche ..4,236.°D 1
Belvidere .....96..G 7
Bemis .....D 15
Beresford ....1,655..I 16
Big Stone City 631..C 16
Bison .....406.°B 4
Black Hawk .....F 2
Blunt .....445..E 9
Bon Homme Colony .....I 14
Bonesteel .....354..I 11
Bonilla .....E 12
Bowdle .....667..B 10
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Bradley .....157..C 14
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Brandt .....132..D 16
Brentford .....94..C 12
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Bristol .....470..B 13
Britton ....1,465.°A 13
Broadland .....45..E 12
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Bruce .....217..E 15
Bryant .....502..E 14
Buffalo .....393.°B 2
Buffalo Gap ..155..H 2
Bullhead .....A 7
Burbank .....J 16
Burke .....892.°I 11
Bushnell .....65..E 16
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Camp Crook ....150..B 1
Canistota .....636..G 15
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Canton .....2,665.°H 16
Caputa .....F 3
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Carter .....17..H 9
Carthage .....362..F 14
Castle Rock .....D 2
Castlewood ....523..D 15
Cavour .....134..E 13
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Central City ..188..E 2
Chamberlain 2,626.°G 10
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Chancellor ....220..H 15
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Clark .....1,356.°D 14
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Cresbard .....224..C 11
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Crooks .....G 15
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De Smet ....1,336.°E 14
Dimock .....167..H 13
Doland .....430..D 13
Dolton .....60..H 14
Draper .....200..F 8
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Elkton .....541..E 16
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Ellsworth ....6,207..F 3
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Epiphany .....G 14
Erwin .....106..E 14
Esmond .....19..F 13
Estelline .....624..E 15
Ethan .....309..G 13
Eureka .....1,547..A 10
Fairburn .....50..G 3
Fairfax .....199..I 11
Fairview .....72..H 16
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Grenville .....154..B 14
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Hayti .....393.°D 15
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Hill City .....389..F 2
Hillhead .....A 14
Hillsview .....19..B 10
Hitchcock ....150..E 12
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Keldron .....A 6
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Lake Norden ..393..E 15
Lake Preston ..812..E 14
Lane .....94..F 12
Langford .....328..B 13
Lantry .....C 6
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Ridgeview .....C 7
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Roslyn .....250..B 14
Roswell .....32..F 14
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Spearfish ...4,661..E 1
Spencer .....385..G 14
Spink .....I 16
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Storla .....G 12
Strandburg ....98..C 15
Stratford .....106..C 12
Sturgis .....4,536.°E 2
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Wounded Knee .....I 4
Yale .....148..E 13
Yankton ...11,919.°I 14
Zell .....D 12

*Does not appear on map; key shows general location.
°County seat.

Source: Latest census figures (1970). Places without population figures are unincorporated areas and are not listed in census reports.

SOUTH DAKOTA / *People*

The 1970 United States census reported that South Dakota had 666,257 persons. The state's population had decreased 2 per cent from the 1960 census figure, 680,514. The U.S. Bureau of the Census estimated that by 1975 the state's population had dropped to about 660,000.

South Dakota's percentage of urban dwellers ranks among the lowest in the nation. Only about two-fifths of the people live in cities and towns. The state has only one Standard Metropolitan Statistical Area (see METROPOLITAN AREA). This is the Sioux Falls metropolitan area, with a population of 95,209.

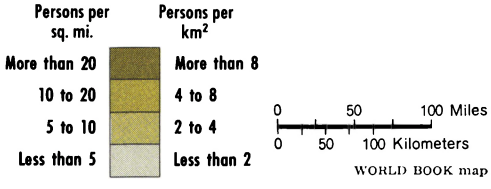
South Dakota has no great manufacturing industries to prompt the growth of large cities. Only Aberdeen, Rapid City, and Sioux Falls have more than 25,000 persons. Most South Dakota towns were established to serve the surrounding agricultural regions, and most lie east of the Missouri River, in the state's chief farming area. Many towns have also grown up in the Black Hills, where mining and the tourist industry prosper. See the separate articles on the cities of South Dakota listed in the *Related Articles* at the end of this article.

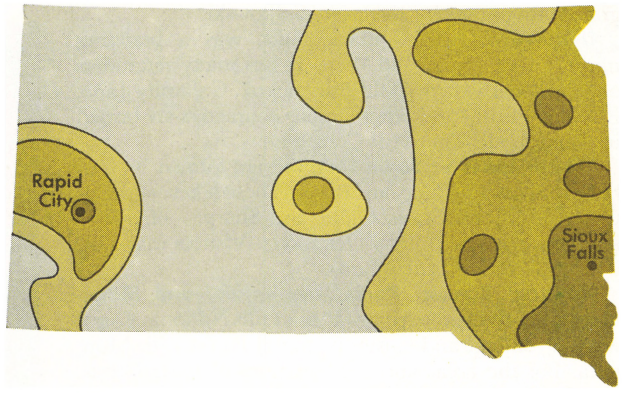
About 98 of every 100 South Dakotans were born in the United States. Most of those born in other countries came from Canada, Denmark, Germany, Norway, and Russia.

Roman Catholics make up the largest single religious group in South Dakota. Lutherans are the second largest group, followed by Methodists, members of the United Church of Christ, and Presbyterians.

POPULATION

This map shows the *population density* of South Dakota, and how it varies in different parts of the state. Population density is the average number of persons who live in a given area.





SOUTH DAKOTA / *Education*

Schools. The first schoolhouse in the South Dakota region opened in 1860 in Bon Homme. The building was torn down after three months, and its logs were used in a stockade built for protection against Indian attacks. The first territorial legislature authorized a public school system in 1862. In 1864, a superintendent of public instruction was appointed.

Today, a seven-member state board of education makes policies for the public school system. The governor appoints the board members, with state Senate approval, to five-year terms. The state superintendent of public instruction serves as the board's chief administrative officer. The board appoints the superintendent to a two-year term. Children must attend school between the ages of 7 and 16 or until they have completed the eighth grade. For the number of students and teachers in South Dakota, see EDUCATION (table).

Libraries and Museums. South Dakota's first library, the Alexander Mitchell Library, was established in Aberdeen in 1884. This library still exists. In 1913, the state legislature established a commission, now called the South Dakota State Library Commission, to improve library services. Today, the state has about 100 public libraries and 8 bookmobiles.

The University of South Dakota campus in Vermillion has the largest library in the state. It owns over 310,000 books. The Sioux Falls Carnegie Library has fine collections on art, biography, history, and music. The State Historical Library in Pierre has excellent materials on South Dakota history.

Museums are operated by the W. H. Over Dakota Museum of South Dakota and the South Dakota School of Mines and Technology in Rapid City. The South Dakota State Historical Museum is in Pierre. Other museums in Rapid City and Sioux Falls exhibit Indian arts and crafts, and historic items. Adams Memorial Museum in Deadwood has many pioneer items on display.

UNIVERSITIES AND COLLEGES

South Dakota has 12 universities and colleges accredited by the North Central Association of Colleges and Secondary Schools. For enrollments and further information, see UNIVERSITIES AND COLLEGES (table).

Name	Location	Founded
Augustana College	Sioux Falls	1860
Black Hills State College	Spearfish	1883
Dakota State College	Madison	1881
Dakota Wesleyan University	Mitchell	1885
Huron College	Huron	1883
Mount Marty College	Yankton	1936
Northern State College	Aberdeen	1901
Sioux Falls College	Sioux Falls	1883
South Dakota, University of	*	*
South Dakota School of Mines and Technology	Rapid City	1885
South Dakota State University	Brookings	1881
Yankton College	Yankton	1881

*For campuses and founding dates, see UNIVERSITIES AND COLLEGES (table).

SOUTH DAKOTA / *A Visitor's Guide*

More than 9 million tourists visit South Dakota yearly. Most of them tour the famous Black Hills. Great numbers of hunters shoot many kinds of game birds and animals in the state each autumn. South Dakota offers visitors breath-taking scenery, and swimming, fishing, and other recreational facilities.

PLACES TO VISIT

Following are brief descriptions of some of South Dakota's many interesting places to visit.

Corn Palace, in Mitchell, is redecorated every fall with murals made of different colors of corn and other grains. Concerts, dances, and many other events are held in the building.

Crazy Horse Memorial, near Custer, is a gigantic sculpture of the great Sioux chief being carved out of a granite mountain by Korczak Ziolkowski.

Deadwood, in the Black Hills, was a brawling mining town of the Old West. It has many reminders of its wild early days. Wild Bill Hickok, Calamity Jane, Preacher Smith, and other famous characters are buried in Deadwood's Boot Hill Cemetery.

"Great Lakes of South Dakota" are formed by four huge dams on the Missouri River. These lakes—Francis Case, Lewis and Clark, Oahe, and Sharpe—offer fishing, boating, and other water sports. Visitors may tour the power plants of the dams.

National Forests, Parks, Memorials, and Monuments. South Dakota shares Black Hills National Forest with Wyoming, and Custer National Forest with Montana. For the areas and chief features of these forests, see NATIONAL FOREST (table). The federal government also administers Wind Cave National Park, Mount Rushmore National Memorial, and Jewel Cave and Badlands national monuments. All are in the Black Hills except Badlands National Monument, which is just southeast of this region. Each has a separate article in WORLD BOOK.

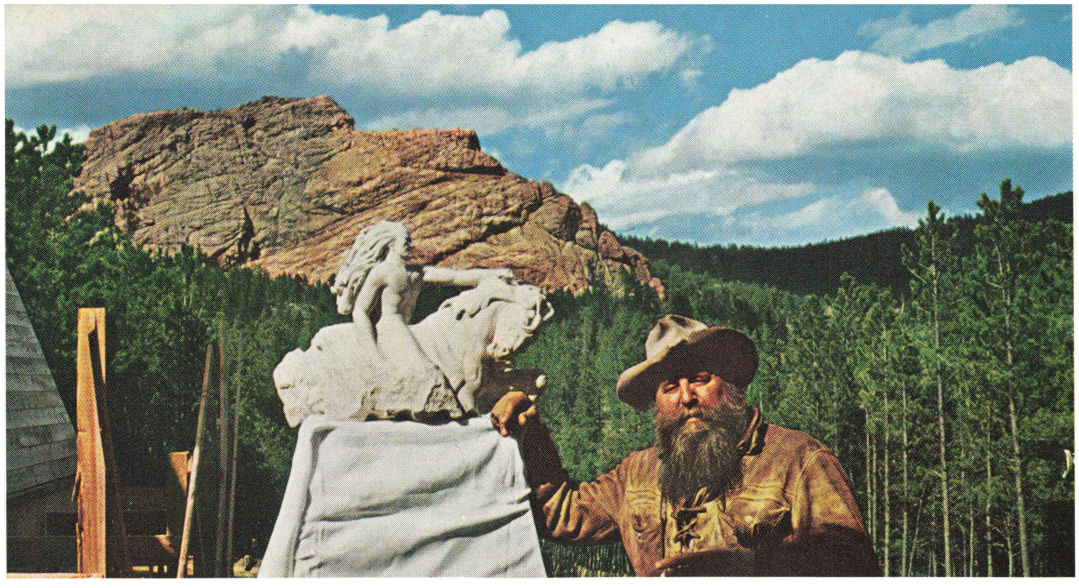
State Parks. South Dakota has 14 state parks. For information, write to Director of Parks and Recreation; Department of Game, Fish and Parks; State Office Building; Pierre, S.Dak. 57501.

Corn Palace in Mitchell

Pheasant Hunting in Eastern South Dakota

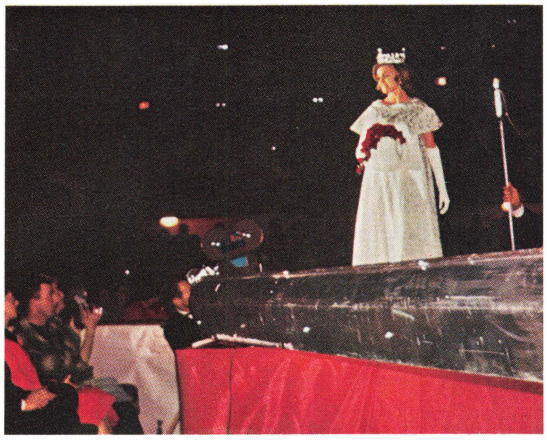
Czech Days Festival in Tabor

All photos from South Dakota Department of Highways unless otherwise indicated



Model of Crazy Horse Memorial and Sculptor Korczak Ziolkowski near Custer

Judging the Snow Queen at the Festival in Aberdeen
Aberdeen Junior Chamber of Commerce



ANNUAL EVENTS

Many South Dakota communities stage fairs, plays, pioneer celebrations, and rodeos. The famous Black Hills Passion Play is staged at Spearfish (see PASSION PLAY [picture]). Other annual events include:

January-March: Governor's Cup Snowmobile Race, from Pierre to Aberdeen (January); Snow Queen Festival in Aberdeen (January); Winter Wonderland (snowmobile events) in Deadwood (February); Little International Stock Show in Brookings (March); Schmeckfest Festival (food tasting) in Freeman (March).

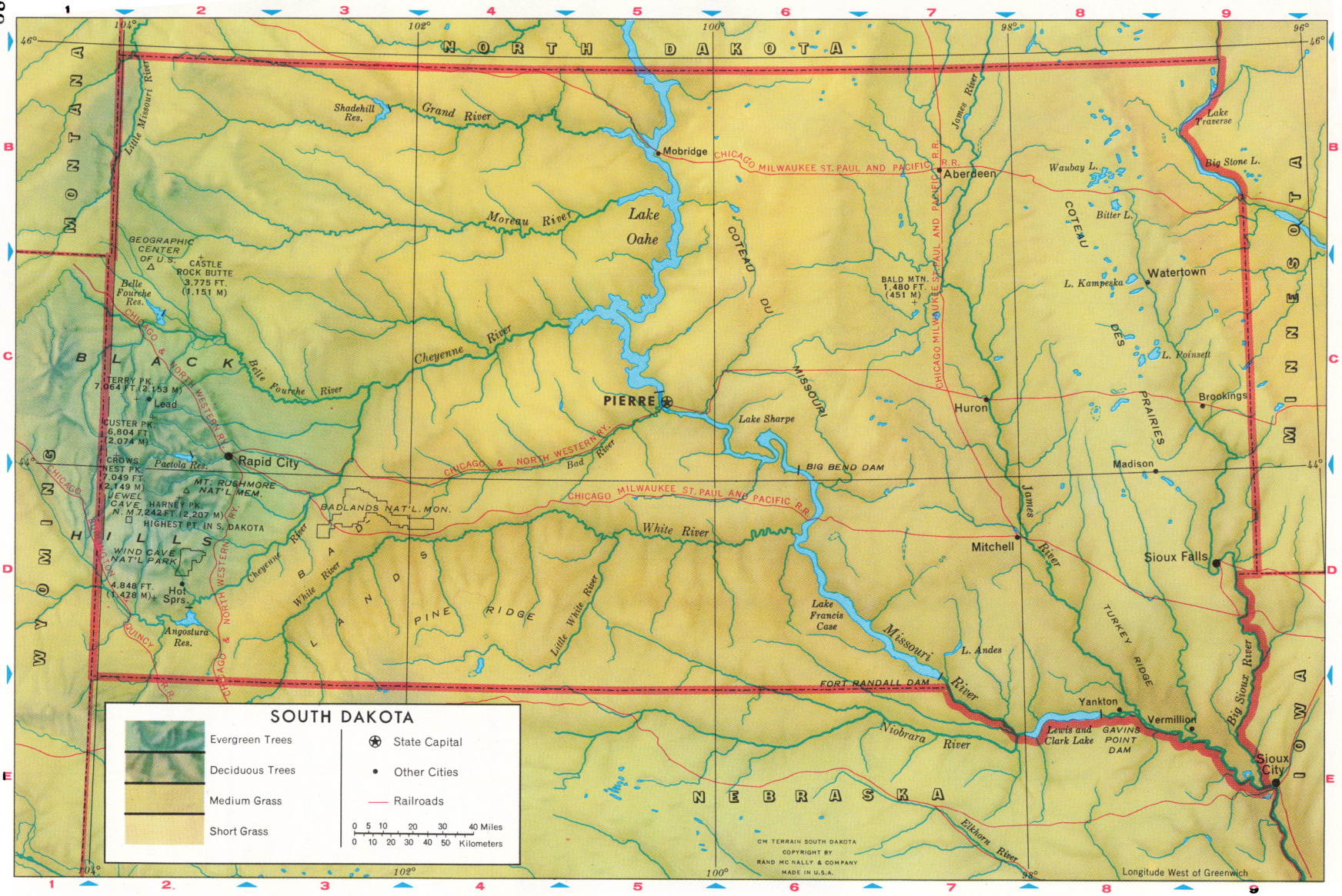
April-June: Czech Days in Tabor (June); Miss South Dakota Beauty Pageant in Hot Springs (June).

July-September: Black Hills Roundup in Belle Fourche (July); Sitting Bull Stampede in Mobridge (July); Days of '76 in Deadwood (August); Oglala Sioux Sun Dance in Pine Ridge (August); State Fair in Huron (August); Cheyenne River Sioux Reservation Fair and Rodeo in Eagle Butte (September); Corn Palace Festival in Mitchell (September).

October-December: Buffalo Feed in Gary (October); State Junior Miss Pageant in Sturgis (November).

Racing Wild Horses at a Rodeo in Belle Fourche

Sioux Festival Dancers in Fort Sisseton State Park



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The Missouri River flows through the middle of South Dakota from north to south. The river marks the western edge of a series of glaciers that crossed eastern South Dakota during the Ice Age. The glaciers leveled off high places, filled in valleys, and created lakes. As the glaciers spread across the region, they dragged or pushed boulders, rocks, and other materials. When the glaciers melted, they left these materials behind. All the materials deposited by the glaciers or by their melted waters are called *drift*. These materials are either unsorted or laid down in layers. Materials deposited directly by the glaciers are unsorted, and are called *till*.

Land Regions. South Dakota has four major land regions: (1) the Young Drift Plains, (2) the Dissected Till Plains, (3) the Great Plains, and (4) the Black Hills. The Young Drift Plains and the Dissected Till Plains together are known as the *Prairies* or *Central Lowlands*.

The Young Drift Plains extend across most of eastern South Dakota. This region is marked by low, rolling hills and glacial lakes. Most of the region's lakes are near its eastern edge. Early French fur traders called the area the *Coteau des Prairies* (Prairie Hills). The northeastern corner of the Prairie Hills ends abruptly at a 600-foot (183-meter) *escarpment* (steep slope) along the Minnesota River Valley. A 300-foot (91-meter) escarpment marks the western end of the Prairie Hills along the James Basin. This basin occupies the western part of the Young Drift Plains. The basin is a flat to slightly rolling lowland. It extends in a wide belt down the width of the state. The James River winds through the basin. A 300-foot (91-meter) escarpment rises along the basin's western edge.

The Dissected Till Plains cover the southeastern corner of South Dakota. Glaciers left large deposits of till over the region. A deep cover of wind-blown soil particles called *loess* then settled on the till. Streams have *dissected* (cut up) the region, giving it a rolling surface.

The Great Plains cover most of the western two-thirds of South Dakota. The Missouri Hills form the eastern edge of the Great Plains. These hills are between the James Basin and the Missouri River. Rolling hills formed by glaciers mark the eastern part of the area.

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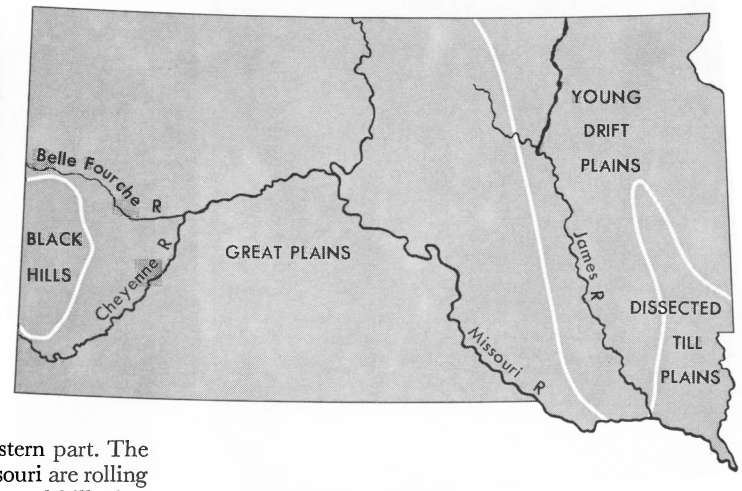
Land Regions of South Dakota



Rugged ridges and valleys mark the western part. The chief features of the land west of the Missouri are rolling plains, canyons, and *buttes* (steep, flat-topped hills that stand alone). Many of the buttes rise from 400 to 600 feet (120 to 180 meters) above the surrounding plains.

Badlands are common in the Great Plains. Wind and water have worn the soft rocks of these regions into steep hills and deep gullies. The nation's most famous badlands lie southeast of the Black Hills. This area has little plant or animal life. See BADLANDS.

The Black Hills are a low, isolated mountain group in west-central South Dakota. The region has great beauty, with deep canyons and towering rock formations. The Black Hills also have rich mineral deposits, and thick forests of tall pines, spruces, and other trees. The state's highest point—7,242-foot (2,207-meter) Harney Peak—rises in the Black Hills. See BLACK HILLS.

Rivers and Lakes. The Missouri River is the state's most important river. The Missouri and its branches drain all the state except the northeastern corner. The Missouri's western branches include the Cheyenne, Grand, Moreau, and White rivers. The Big Sioux, James, and other rivers join the Missouri in the east.

Most of the state's lakes were formed during the Ice Age by glaciers. A series of glacial lakes stretches

Flocks of Sheep graze in the Great Plains region of western South Dakota. Large-scale ranching in this "short grass country" makes the state a leader in the production of sheep and wool.

Grant Heilman

across eastern South Dakota. The state's biggest lakes are man-made, created by four dams on the Missouri River. The largest lake is Lake Oahe, 250 miles (402 kilometers) long, created by Oahe Dam. Fort Randall Dam created Lake Francis Case, 140 miles (225 kilometers) long. Lake Sharpe, a reservoir formed by Big Bend Dam, is 80 miles (130 kilometers) long. Gavins Point Dam forms Lewis and Clark Lake, 25 miles (40 kilometers) long.

Medicine Lake, near Florence in Codington County, has a salt content of more than 4 per cent, compared with about $3\frac{1}{2}$ per cent for seawater. Its water was once believed to have medicinal qualities.

H. Armstrong Roberts

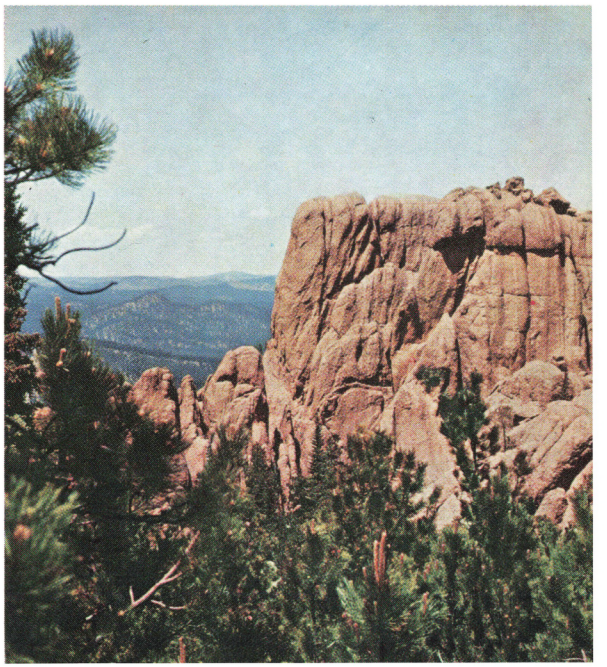
Badlands National Monument, *right,* is a desolate area in southwestern South Dakota. Water and wind have worn away the land, leaving deep ravines, steep ridges, and colorful cliffs. The area is part of the Great Plains region.

Falls of the Big Sioux River are near the city of Sioux Falls. The river flows through the Dissected Till Plains region.

Lake Kampeska, *below,* lies near the center of a broad belt of lakes in South Dakota's Young Drift Plains region.

South Dakota Department of Highways

Towering Granite Boulders, *right,* form the tops of rugged mountains in the Black Hills. This region has many rich mineral deposits.



SOUTH DAKOTA / *Climate*

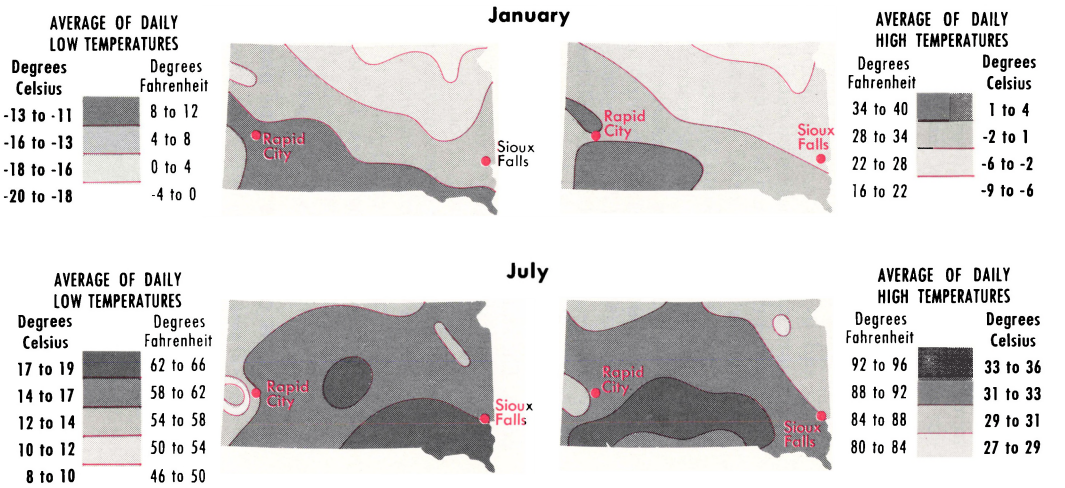
South Dakota is far from any large body of water. For this reason, the state has great ranges in temperatures. Temperatures over 100° F. (38° C) occur every summer. But even the hottest days are seldom uncomfortable, because the humidity is low. Below-zero temperatures are common on midwinter mornings. Average July temperatures range from 78° F. (26° C) in south-central South Dakota to 68° F. (20° C) in the Black Hills. The state's record high temperature, 120° F. (49° C), was set at Gannvalley (or Gann Valley) on July 5, 1936. Average January temperatures range from 10° F. (−12° C) in the northeast to 22° F. (−6° C) in the southwest. The state's record low, −58° F.(−50° C), was set at McIntosh on Feb. 17, 1936.

South Dakota's annual *precipitation* (rain, melted snow, and other forms of moisture) ranges from about 13 inches (33 centimeters) in the northwest to about 25 inches (64 centimeters) in the southeast. Most of the rain falls in the growing season, from April through September. The heaviest snowfalls occur in February and early March.

Early Winter Snow covers a pasture near Hermosa. Cattle can dig through the light snow to get grass. But ranchers must bring food to the herds when heavy snow falls in midwinter.

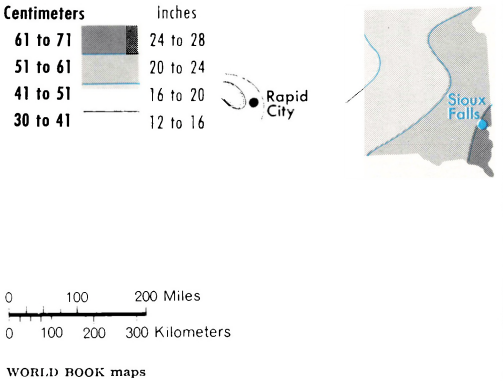
H. Armstrong Roberts

SEASONAL TEMPERATURES



AVERAGE YEARLY PRECIPITATION

(Rain, Melted Snow and Other Moisture)



WORLD BOOK maps

AVERAGE MONTHLY WEATHER

	RAPID CITY					SIOUX FALLS				
	Temperatures F°		Temperatures C°		Days of Rain or Snow		Temperatures F°		Temperatures C°		Days of Rain or Snow
	High	Low	High	Low			High	Low	High	Low	
JAN.	33	9	1	-13	7	JAN.	24	4	-4	-16	5
FEB.	36	12	2	-11	6	FEB.	30	9	-1	-13	6
MAR.	43	20	6	-7	9	MAR.	42	22	6	-6	9
APR.	57	32	14	0	8	APR.	59	34	15	1	8
MAY	67	43	19	6	12	MAY	71	45	22	7	10
JUNE	76	52	24	11	13	JUNE	80	56	27	13	11
JULY	86	59	30	15	9	JULY	88	62	31	17	10
AUG.	85	57	29	14	8	AUG.	85	60	29	16	10
SEPT.	74	47	23	8	6	SEPT.	75	49	24	9	7
OCT.	62	36	17	2	5	OCT.	63	37	17	3	6
NOV.	47	24	8	-4	5	NOV.	43	21	6	-6	5
DEC.	37	14	3	-10	5	DEC.	29	9	-2	-13	6

Natural Resources. South Dakota's most precious natural resource is its fertile soil, the basis of its great agricultural economy. The state also has rich mineral resources. Most of the forest reserves are in the Black Hills. Other plant life and animal life are abundant.

Soil. The soils that cover most of eastern South Dakota developed from glacial materials. These soils are loamy, and range in color from dark brown to black. A belt of loess stretches along the east bank of the Missouri River. A deep deposit of loess also covers southeastern South Dakota. The soils of eastern South Dakota are good for growing corn, wheat, and other crops. Most of the soils west of the Missouri were formed from the weathering of various shales. These soils make good grazing lands.

Minerals. South Dakota's most important metallic mineral is gold. It is found in the Black Hills. A rich vein of gold ore, the Homestake lode, was discovered at Lead in 1876. This vein has yielded millions of tons of gold ore, and it still has reserves of about 11 million short tons (10 million metric tons). The gold ore contains some silver. Other metallic minerals in the Black Hills include copper, iron, lead, silver, and uranium. Molybdenum, uranium, and vanadium occur in southwestern and northwestern South Dakota. The northwestern counties have about 2 billion short tons (1.8 billion metric tons) of *lignite*, a low-grade coal. Much of western South Dakota lies in the great Williston Basin. This basin is a rich petroleum reservoir that extends across North Dakota and eastern Montana into southern Canada. Most South Dakota counties have sand and gravel deposits of commercial value. Granite is quarried in the northeast, and limestone in the Black Hills area. Manganese ore deposits are found in south-central South Dakota. Other minerals, found chiefly in the Black Hills, include beryl, clays, feldspar, gypsum, and mica.

Forests cover only about 1,700,000 acres (688,000 hectares), or 3½ per cent of South Dakota. Most of the forests lie in the Black Hills. These forests contain chiefly cone-bearing trees, including junipers, ponderosa pines, and spruces. Ashes, cottonwoods, oaks, and other hardwoods are scattered over the rest of the state.

Other Plant Life. The American pasqueflower, South Dakota's state flower, blooms on hillsides in early spring. Black-eyed Susans, goldenrod, mariposa lilies, poppies, sunflowers, and wild orange geraniums grow on the eastern prairies. Cactus plants are common in western South Dakota. Bluebells, forget-me-nots, lady's-slippers, and larkspurs blossom in the Black Hills.

Animal Life. White-tailed deer live in all parts of South Dakota. They are most numerous in the Black Hills and in the woodlands of the Missouri River Valley. Pronghorns roam the land west of the Missouri. Mule deer graze in the rocky butte and canyon areas of the northwest. Bighorn sheep, elks, and Rocky Mountain goats live in the Black Hills. About 2,000 buffaloes, the nation's largest herd, roam Custer State Park in the Black Hills.

The ring-necked pheasant, the state bird, is found throughout South Dakota. Hungarian partridges nest in northern parts of the state, and sage grouse in the extreme northwest. Sharp-tailed grouse and prairie chickens are found chiefly west of the Missouri River. Wild turkeys feed in the Black Hills.

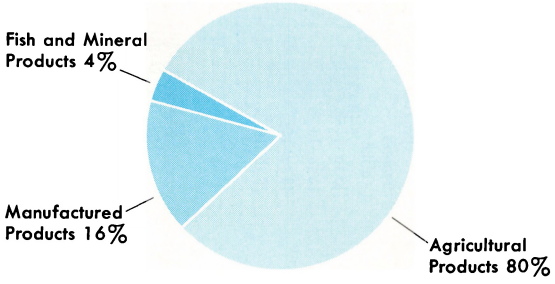
Bass, bluegills, crappies, perch, walleyed pike, and other fishes are abundant in the glacial lakes of northeastern South Dakota. Among the fishes in the Missouri River and its branches are bass, catfish, paddlefish, sauger, and sturgeon. Fishermen catch brook and rainbow trout in the rivers and lakes of the Black Hills.

Agriculture accounts for 80 per cent of the value of all goods produced in South Dakota. The state's farm income totals about $1 billion yearly. South Dakota has about 50,000 farms and ranches. They range in size from about 100 acres (40 hectares) in the southeast to about 75,000 acres (30,000 hectares) in the west. They average about 1,000 acres (400 hectares).

Livestock and Livestock Products provide South Dakota farmers with about three-fourths of their total farm income. The state is a leader in raising beef cattle, hogs, lambs, and sheep. Pastures cover about 29 million acres (11.7 million hectares), or more than half the state. Beef cattle graze on the enormous ranches of the western section. The ranchers often ship their calves and yearlings to cattlemen called *feeders* in eastern South Dakota or in neighboring states. The feeders fatten the young cattle on grains, and then send them to market. Most of South Dakota's sheep and lambs come from

PRODUCTION OF GOODS IN SOUTH DAKOTA

Total value of goods produced in 1971—$1,434,023,000



Percentages are based on farm income, value added by manufacture, and value of fish and mineral production. Fish products are less than 1 per cent.

Sources: U.S. government publications, 1971-1973.

EMPLOYMENT IN SOUTH DAKOTA

Total number of persons employed in 1972—245,000

	Number of Employees
Government	57,600
Agriculture	55,600
Wholesale & Retail Trade	47,600
Community, Business, & Personal Services	36,700
Manufacturing	18,000
Transportation & Public Utilities	11,200
Construction	8,400
Finance, Insurance, & Real Estate	7,800
Mining	2,100

Sources: *Employment and Earnings*, May, 1973, U.S. Bureau of Labor Statistics; U.S. Bureau of Employment Security.

the northwest area. The state is a leader in wool production. Hogs are raised in the southeast. Most of the state's chickens and eggs are also produced in this section. Farmers raise dairy cattle throughout the eastern part of the state, and milk is an important product.

Field Crops are raised on about a fourth of South Dakota's land area. Most of the crops are grown east of the Missouri River. South Dakota is a leading state in the production of alfalfa seed, corn, flaxseed, hay, oats, rye, spring wheat, and sweet clover seed. Farmers in the southeastern section of the state harvest the most corn and oats. Soybeans are also grown in this area. Most of the flaxseed and much of the barley comes from the northeastern section. Rye and wheat are raised chiefly in the northern half of the state, and in counties just east of the Missouri River. Federal irrigation projects have made the land in some western areas suitable for growing crops. Crops grown on this land include alfalfa, barley, corn, milo, and oats.

Manufacturing accounts for only 16 per cent of the value of all goods produced in South Dakota. Goods manufactured in the state have a *value added by manufacture* of about $226 million yearly. This figure represents the value created in products by South Dakota's industries, not counting such costs as materials, supplies, and fuels.

South Dakota has over 800 manufacturing and processing plants. Most of them employ fewer than 50 persons. Food processing is by far the leading manufacturing activity, with an annual value added by manufacture of about $127 million. Meat processing and packing is the single most important industry. The largest plant is in Sioux Falls. Other plants are in Huron, Mitchell, and Yankton. Poultry is dressed and packed in Madison, Rapid City, Sioux Falls, Watertown, and other cities. Creameries and dairy-processing plants operate in Mitchell, Rapid City, Sioux Falls, and many other towns. Rapid City has flour and feed mills. Feed mills also operate in Sioux Falls.

A state-owned plant near Rapid City manufactures cement, and a number of cities make concrete products. Factories in Belle Fourche process *bentonite* (a type of clay), and make bricks, tiles, and other clay products. Lumber mills operate in Custer, Hill City, Rapid City, Spearfish, and Whitewood. Rapid City also makes products of clay, glass, and stone. Nonelectrical machinery, such as farm and construction equipment, is produced in Madison, Salem, Sioux Falls, and Yankton. Printing and publishing are important in Rapid City and Sioux Falls.

Mining accounts for about 4 per cent of the value of all goods produced in South Dakota, or about $63 million yearly. About a third of this total comes from gold. South Dakota is one of the most important gold-producing states, and supplies over a fourth of the nation's output. The Homestake Mine at Lead is the largest gold-producing mine in the Western Hemisphere. It has produced millions of ounces of gold since the first ore was mined and milled in 1876. It yields about 407,000 troy ounces (12,660 kilograms) annually.

Almost every South Dakota county produces sand and gravel. Sand and gravel are used chiefly by the construction industry. Quarries in Grant County are the state's chief sources of granite, which is used as building and monument stone. Uranium is mined in southwestern South Dakota.

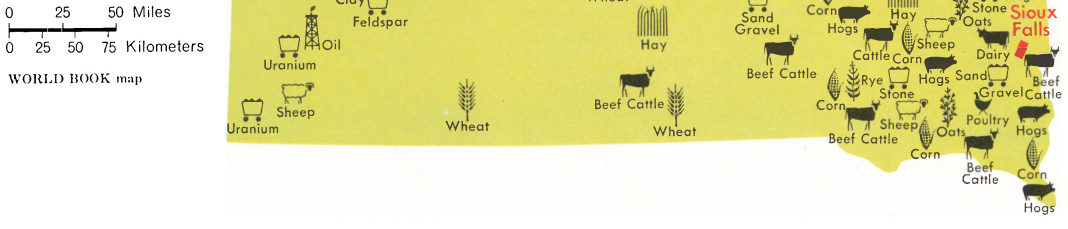
In 1954, South Dakota drilled its first oil-producing well, in Harding County in the northwestern part of the state. Today, the county has about 25 producing wells. Dewey and Fall River counties also have several producing wells.

Other minerals produced in South Dakota include beryllium, clays, feldspar, gemstones, gypsum, limestone, mica, quartz, quartzite, and silver.

Electric Power. About 90 per cent of South Dakota's electric power comes from hydroelectric projects. The rest is generated by fuel-burning plants. Four huge Missouri River dams—Big Bend, Fort Randall, Gavins Point, and Oahe—supply most of South Dakota's hydroelectric power. The swift streams of the Black

FARM AND MINERAL PRODUCTS

This map shows where the state's leading farm and mineral products are produced. The major urban area (shown on the map in red) is the state's important manufacturing center.



Hills are also used to generate electric power. See FORT RANDALL; OAHE DAM.

Transportation. The wide Missouri River provided the first great highway into South Dakota. Early explorers, fur traders, and missionaries sailed up the river in canoes or flat-bottomed boats. In 1831, the first steamboat reached the site of what is now Fort Pierre. During the 1870's, gold was discovered in the Black Hills. Prospectors carved trails into the region as they rushed to the gold fields in stagecoaches and oxcarts. In 1872, the first railroad to enter South Dakota reached Yankton. By 1880, two rail lines crossed eastern South Dakota to the Missouri River. A railroad reached the Black Hills in 1886.

Today, six railroads operating on about 4,000 miles (6,400 kilometers) of track in South Dakota provide freight services. No passenger railroads cross the state. South Dakota has about 85,000 miles (137,000 kilometers) of roads and highways. Over two-thirds of them are surfaced. Commercial airlines serve nine cities and towns. South Dakota has more than 100 airports and airfields.

Communication. South Dakota's first newspaper, the *Dakota Democrat*, was established in Sioux Falls in 1859. The oldest newspaper still published in the state is the *Yankton Press and Dakotan*. It was founded as the *Weekly Dakotian* in 1861, and became a daily in 1875. South Dakota has more than 10 daily newspapers, about 150 weeklies, and about 30 periodicals. Daily newspapers with the largest circulations include the *Rapid City Journal* and the *Sioux Falls Argus-Leader*.

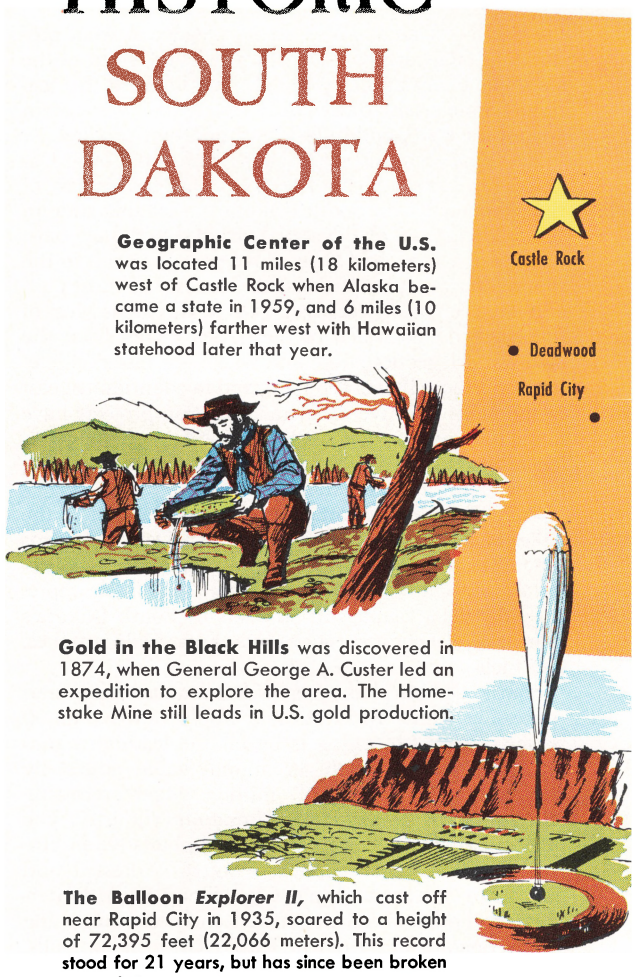
The South Dakota School of Mines and Technology established the state's first radio station, WCAT. The station was licensed in Rapid City in 1922. The first television station, KELO, began operating in Sioux Falls in 1953. Today, about 40 radio stations and 15 television stations serve the state.

SOUTH DAKOTA / *History*

Indian Days. Three major Indian tribes lived in the South Dakota region before white explorers first arrived. The Arikara were farmers who made their homes near the mouth of the Cheyenne River, and north of the Cheyenne along the Missouri River. The Cheyenne Indians lived and hunted in the western part of the Cheyenne River area, and also along the White River and in the Black Hills. The Sioux, or Dakota, were hunters and warriors who followed the buffalo herds.

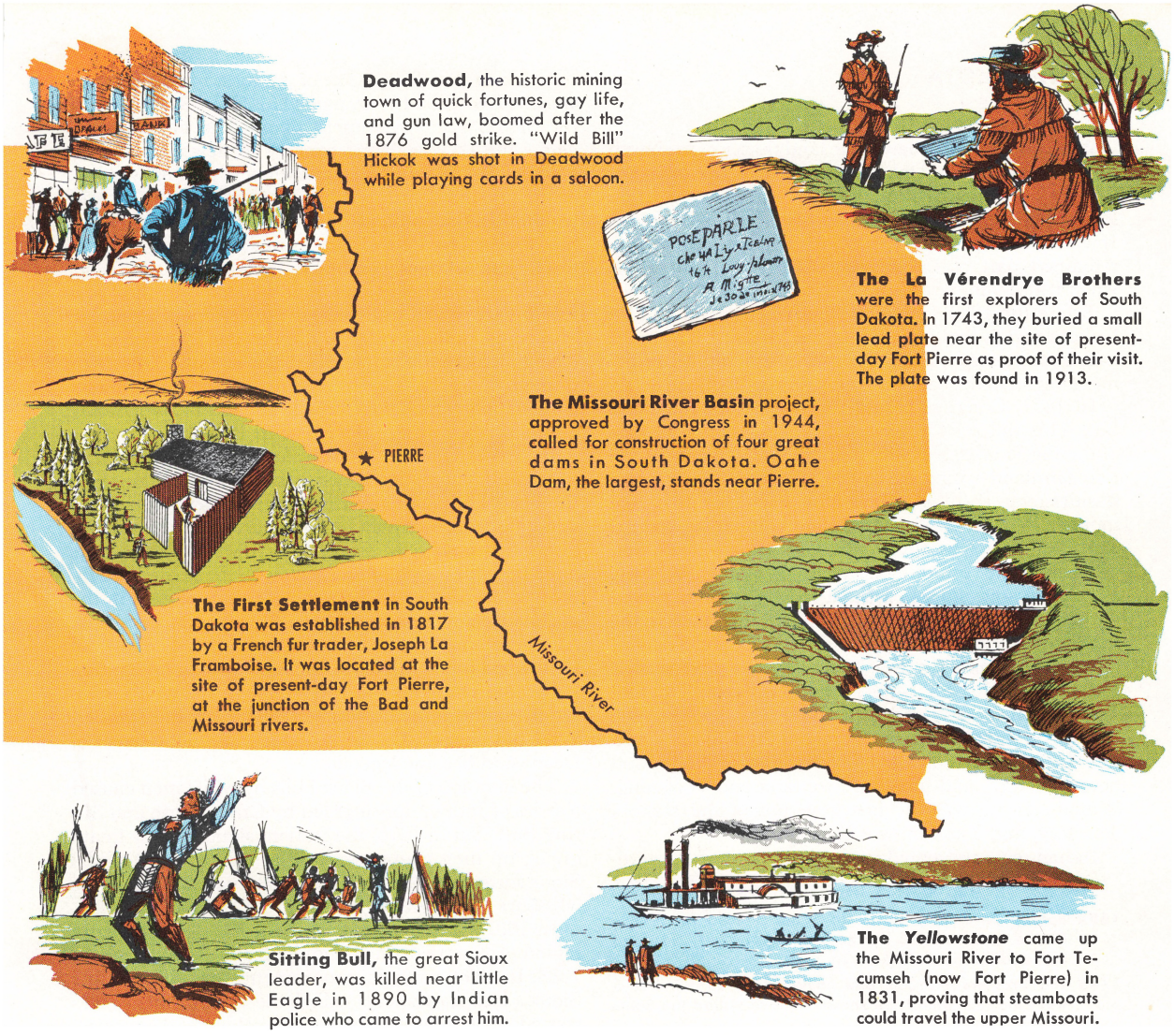
Exploration and Fur Trade. In 1682, Robert Cavelier, Sieur de la Salle, claimed for France all the land drained by the Mississippi River system. This vast territory included what is now South Dakota, because the waters of the Missouri River flow into the Mississippi.

The French-Canadian explorers François and Louis-Joseph La Vérendrye were the first white men known to have visited the South Dakota area. In 1743, the two brothers buried a small lead plate near the site of present-day Fort Pierre to prove they had been there. Schoolchildren found the plate in 1913, and the South Dakota State Historical Museum now owns it.



Fort Randall Dam, completed in 1956, crosses the Missouri River near Lake Andes. It is 165 feet (50 meters) high and 10,700 feet (3,261 meters) long.

South Dakota Dept. of Highways



In 1762, France gave its land west of the Mississippi River to Spain. Spain returned it to France in 1800. In 1803, the United States bought this territory, called Louisiana, from France (see LOUISIANA PURCHASE).

About 1785, Pierre Dorion, a French fur trader, arrived in the lower James River Valley, near what is now Yankton. He became the first white man to settle permanently in the South Dakota region.

In 1804, President Thomas Jefferson sent Meriwether Lewis and William Clark to explore the Louisiana Territory and to blaze a trail to the Pacific Ocean. In August, the explorers camped in the South Dakota region for the first time, near what is now Elk Point. They followed the Missouri River through the region. Lewis and Clark passed through again in 1806 on their return from the Pacific. Their reports of the abundant fur-bearing animals in the region attracted an increased number of fur traders. The explorers had also established friendly relations with many Indian tribes.

The most important trading post was built in 1817 at the mouth of the Bad River, on the site of present-day Fort Pierre. This lonely post became the first permanent settlement in the South Dakota region. It was established by Joseph La Framboise, a French trader.

The first large-scale military action against South Dakota Indians took place in 1823. The Arikara tribe attacked a fur-trading party led by General William Ashley, lieutenant governor of Missouri. The federal government sent troops under Colonel Henry Leavenworth to punish the tribe. The Sioux, traditional enemies of the Arikara, joined in fighting them.

In 1831, the steamboat *Yellowstone* sailed up the Missouri River from St. Louis to Fort Tecumseh (now Fort Pierre). The *Yellowstone* proved that steamboats could travel the upper Missouri. This development further spurred the fur trade in South Dakota. Large cargoes could be shipped in far less time than it took for flat-bottomed boats that were moved by the river currents. The fur trade thrived for several years, but began to decline by 1850. The number of fur-bearing animals had started to decrease, and the demand for furs fell as silk became more fashionable.

Agricultural Settlement. The land that became North Dakota and South Dakota was part of the Missouri Territory between 1812 and 1834. The eastern section later belonged, in turn, to the Michigan, Wisconsin, Iowa, and Minnesota territories. The western section remained part of the Missouri Territory until 1854, when it became part of the Nebraska Territory.

Before the 1850's, all white settlement in the South Dakota region had been along the Missouri River and had been related to the fur trade. Agricultural settlement began in the eastern section during the late 1850's.

In 1857, Congress passed the Minnesota statehood bill. This bill set the new state's western border east of the Big Sioux River. But nothing was done about the rich farmland westward to the Missouri River. Some businessmen and politicians saw a chance to make money. They quickly formed land companies, gained control of choice locations, and laid out townsites. Settlements were established at Sioux Falls, Medary, Flandreau, and other points. In 1858, the Sioux signed a treaty with the government giving up their land in the southeastern corner between the Big Sioux and Missouri rivers. The opening of this land attracted more settlers to the South Dakota region. Yankton, Vermillion, and Bon Homme were founded in 1859.

Territorial Days. Congress created the Dakota Territory in 1861. It consisted of present-day North and South Dakota, and much of Montana and Wyoming. William Jayne was the first governor of the Dakota Territory, and Yankton was the capital.

Indian wars prevented rapid settlement of the territory during the 1860's. One of the most important wars was the Red Cloud War, named for Chief Red Cloud of the Sioux. The government planned to build a road across the Powder River country to newly discovered gold fields in Wyoming. At the time, Wyoming was part of the Dakota Territory. Red Cloud believed the road would ruin the Indians' hunting grounds. In 1866, the Sioux attacked troops sent to make a survey for the road. The Indians continued their raids until 1868, when the government met their demands. In the Laramie Treaty signed that year, the government agreed to give up its military posts in the Powder River country. The government also promised not to build any roads through the area. The treaty created the Great Sioux Reservation, which covered all the land in present-day South Dakota west of the Missouri River.

In 1874, General George A. Custer violated the Laramie Treaty when he led a military expedition into the Black Hills. The government had ordered him to investigate reports of gold in the mountains. The soldiers discovered gold near the present town of Custer. The news brought a rush of prospectors to the area. In 1876, prospectors discovered far richer deposits of gold in the area between the present towns of Lead and Deadwood. Another stampede of gold seekers followed. The town of Deadwood sprang up as the center of mining operations. It became a brawling, wide-open town, and won a reputation as the most lawless settlement on the frontier. Wild Bill Hickok, Calamity Jane, and other citizens of Deadwood became legends.

The invasion of the Black Hills by white men caused a series of Indian uprisings led by Crazy Horse and Sitting Bull. But in 1876, the Indians signed a new treaty giving up their claims to the Black Hills. Most of the Sioux surrendered and settled on reservations west of the Missouri River. Sitting Bull fled to Canada.

In 1881, Sitting Bull returned to the South Dakota region. He settled on Standing Rock Reservation in 1883. In 1890, a religious movement spread among the Sioux. This movement, called the Ghost Dance, was started by an Indian named Wovoka (see WOVOKA). Army leaders feared the Ghost Dance would lead to another Sioux uprising. They sent Indian police to arrest Sitting Bull, but he resisted and was killed. Some of Sitting Bull's followers fled the reservation and joined Chief Big Foot's band of Sioux on the Cheyenne River. Federal troops caught up with the Indians and took them to a cavalry camp on Wounded Knee Creek. There, the soldiers began to disarm the Sioux. A bloody battle began when someone fired a rifle. The soldiers massacred about 200 Indian men, women, and children. The Battle of Wounded Knee was the last big fight between Indians and white men on the northern plains. See INDIAN WARS (The Sioux Wars).

Statehood. A great land boom followed the discovery of gold in the Black Hills. Thousands came to seek gold. But many more came to farm in other sections of South Dakota. An enormous land rush began in 1878. Between 1878 and 1887, farmers and speculators poured into South Dakota. They acquired more than 24 million acres (9.7 million hectares) of public lands offered by the government. In 1870, the region had a population of less than 12,000. By 1890, the population had soared to 348,600. Most of the settlers came from neighboring states, but many came from Germany, Great

IMPORTANT DATES IN SOUTH DAKOTA

1682 Robert Cavelier, Sieur de la Salle, claimed for France all the land drained by the Mississippi River. This land included the South Dakota region.

1743 The brothers François and Louis-Joseph La Vérendrye were the first white men known to have visited the South Dakota region.

1803 The United States acquired South Dakota through the Louisiana Purchase.

1804, 1806 Meriwether Lewis and William Clark passed through South Dakota on their expedition to and from the Pacific Ocean.

1817 Joseph La Framboise established the first permanent settlement in South Dakota. The settlement was located at what is now Fort Pierre.

1831 The first steamboat reached Fort Tecumseh (now Fort Pierre).

1861 Congress created the Dakota Territory.

1868 The Laramie Treaty ended the Red Cloud War.

1874 Gold was discovered in the Black Hills.

1889 South Dakota became the 40th state on November 2.

1927 Gutzon Borglum began work on Mount Rushmore National Memorial.

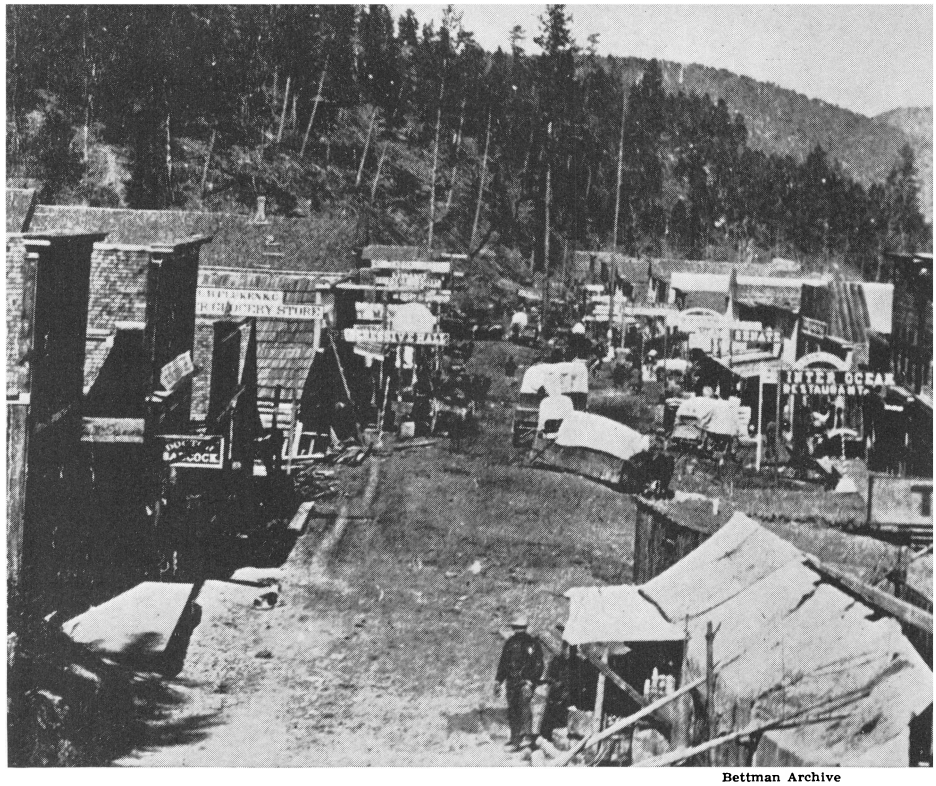
1930's South Dakota suffered its worst drought.

1944 Congress authorized the Missouri River Basin Project, including construction of Fort Randall, Oahe, Gavins Point, and Big Bend dams in South Dakota.

1962 Titan missiles became operational in South Dakota.

1963 Minuteman missiles became operational in South Dakota.

1973 A group of armed Indians seized the village of Wounded Knee and occupied it for 71 days.



Bettman Archive

Boom Town of Deadwood sprang up in 1876 after rich gold deposits were found in the Black Hills. The Homestake, the richest gold mine in the Western Hemisphere, was established in Lead at that time. It is still in operation.

Britain, Norway, Russia, and other European countries.

Railroad building also boomed during this period. By 1880, two railroads had crossed eastern South Dakota to the Missouri River. In 1886, a railroad reached the Black Hills. Many towns sprang up along the rail lines. During the late 1870's and the 1880's, cattlemen entered the open rangeland west of the Missouri. The rush of miners and merchants to the Black Hills and the needs of the Indian agencies and military posts had created a heavy demand for meat.

During the 1870's, a movement began to divide the Dakota Territory into two parts. The major population centers had grown up far apart—in the northeastern and southeastern corners of the territory. The two groups of settlers wanted to develop separate governments. In February, 1889, Congress set the present boundary between South Dakota and North Dakota. It also passed an *enabling act*, which allowed the two regions to set up the machinery to become states (see ENABLING ACT). On Nov. 2, 1889, North Dakota and South Dakota entered the Union as the 39th and 40th states. South Dakotans elected Arthur C. Mellette, a Republican, as their first governor. Pierre became the state capital in 1889, shortly after South Dakota gained statehood.

The Early 1900's. The population of South Dakota had climbed to almost 350,000 by the time it became a state. But little growth occurred during the first 10 years of statehood. A severe drought began in 1889, and lasted until 1897. In 1890, part of the Great Sioux Reservation between the White and Cheyenne rivers was opened to settlement. But few settlers came.

Prosperity returned to South Dakota in the early 1900's. The drought had ended, and prices for farm crops were good. The government opened more new Indian lands in the west, and thousands of settlers poured into the state. Some of this land was offered through great land lotteries. People registered for land and received claims if they were lucky in the lottery drawings. Special trains brought people from all parts of the United States to take part in the lotteries.

By 1910, South Dakota's population had soared to almost 584,000. Between 1900 and 1910, the railroads added more than 1,100 miles (1,770 kilometers) of track in the state. Most of it was laid west of the Missouri River to serve the growing sheep and cattle ranches.

State Experiments. The prosperity and population growth of the first 10 years of the 1900's ended in 1911. Drought again hit the state. In 1915, South Dakota had about the same number of persons it had in 1910.

In 1915, a state law was passed guaranteeing the safety of bank deposits. This law was the first step in a program designed to promote the social and economic welfare of South Dakota's people. Later, the state loaned millions of dollars to farmers. The state also bought a coal mine, built a cement-making plant, and operated an insurance program against damage by hail. By 1932, all except the cement plant had failed because of mismanagement.

The prices of South Dakota's farm products increased after the United States entered World War I in 1917. The value of the state's farmland doubled. The 1920's were years of good rainfall and fine crops. But the state's economy suffered after 1925 because of lower farm prices and bank failures. Then, in 1930, the worst drought and grasshopper plague in South Dakota's history began. Except for some relief in 1932 and 1935, the drought lasted for 10 years. It was accompanied by great dust storms called *black blizzards*. In addition, the entire nation was hit by the Great Depression. Prices for South Dakota's farm products sank lower and lower.

THE GOVERNORS OF SOUTH DAKOTA

	Party	Term
1. Arthur C. Mellette	Republican	1889-1893
2. Charles H. Sheldon	Republican	1893-1897
3. Andrew E. Lee	Populist	1897-1901
4. Charles N. Herreid	Republican	1901-1905
5. Samuel H. Elrod	Republican	1905-1907
6. Coe I. Crawford	Republican	1907-1909
7. Robert S. Vessey	Republican	1909-1913
8. Frank M. Byrne	Republican	1913-1917
9. Peter Norbeck	Republican	1917-1921
10. W. H. McMaster	Republican	1921-1925
11. Carl Gunderson	Republican	1925-1927
12. W. J. Bulow	Democratic	1927-1931
13. Warren Green	Republican	1931-1933
14. Thomas "Tom" Berry	Democratic	1933-1937
15. Leslie Jensen	Republican	1937-1939
16. Harlan J. Bushfield	Republican	1939-1943
17. M. Q. Sharpe	Republican	1943-1947
18. George T. Mickelson	Republican	1947-1951
19. Sigurd Anderson	Republican	1951-1955
20. Joseph J. Foss	Republican	1955-1959
21. Ralph Herseth	Democratic	1959-1961
22. Archie Gubbrud	Republican	1961-1965
23. Nils Boe	Republican	1965-1969
24. Frank L. Farrar	Republican	1969-1971
25. Richard F. Kneip	Democratic	1971-

The population of the state also began to decline. In 1930, South Dakota's population had reached a record 692,849. By 1940, it had fallen to 642,961.

The federal government provided money and jobs to help the distressed farmers. The Civilian Conservation Corps (CCC) gave thousands of young men jobs in the forests of the Black Hills. The Works Progress Administration (WPA) provided money to construct bridges, buildings, and other projects. The government also helped farmers plant wheatlands with grasses whose roots reach deep for moisture and hold the soil in place.

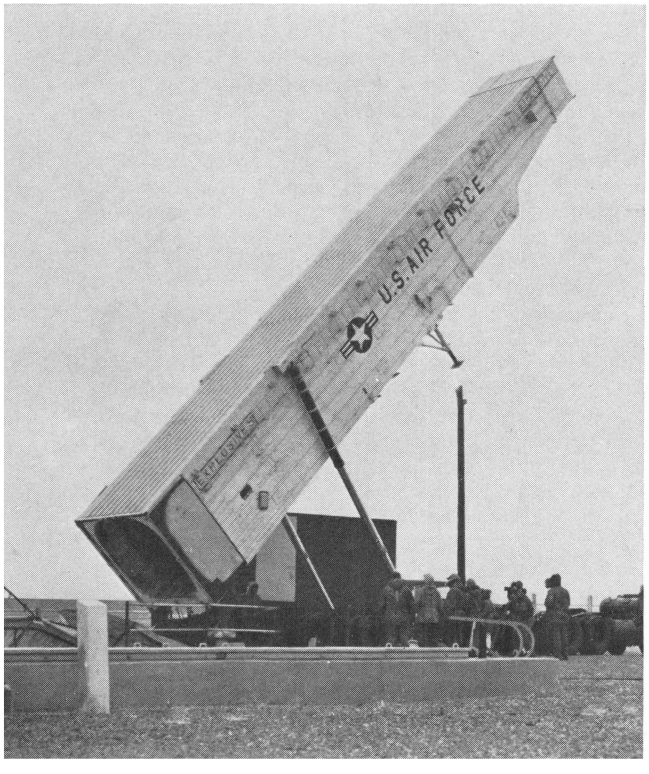
The Mid-1900's. During World War II (1939-1945), South Dakota farmers broke production records in supplying food. The increased use of machinery enabled farmers to do more work but, at the same time, made many farmworkers jobless. Thousands of farmworkers moved to towns and cities in search of jobs, but many could not find employment. As a result, large numbers of people—mostly young persons—left the state. To decrease its dependence on farming, South Dakota started a drive to broaden its economy. This effort included developing the Missouri River Basin, increasing tourism, and attracting new industry.

In 1944, Congress authorized the Missouri Basin Project. This huge program was designed to provide electric power, flood control, and irrigation throughout the basin. Part of the project called for construction of four hydroelectric dams on the Missouri River in South Dakota. Work began on Fort Randall Dam in 1946, on Oahe Dam in 1948, on Gavins Point Dam in 1952, and on Big Bend Dam in 1960. By 1966, all four dams were producing hydroelectric power.

The four dams on the Missouri River created four large lakes—Francis Case, Lewis and Clark, and Sharpe lakes and Oahe Reservoir. The lakes became known as the "Great Lakes of South Dakota." These lakes, along with many new highways, attracted additional tourists to the state. Tourism became South Dakota's second largest industry, after agriculture.

Unloading a Minuteman Missile at a launch site near Newell requires special machinery. Shafts tilt the boxlike container upright. Then, the huge missile is lowered into a pit.

U.S. Air Force



In 1954, the state government created the Industrial Development Expansion Agency (IDEA) to find new industry. By 1969, development corporations had been organized in 60 communities. These corporations work to attract new businesses and to help others expand.

During the 1960's, the government built a number of defense projects in South Dakota. Today, missile sites dot the western part of the state. They are directed from Ellsworth Air Force Base near Rapid City.

South Dakota Today. In the 1970's, South Dakota hopes to halt the departure of young people by stepping up its campaign to broaden the economy and create jobs. To attract industry, business leaders point out that the state does not tax personal or corporation incomes. They also call attention to the state's clean air, abundant water supplies, and low electric power rates.

In 1970, a new $4\frac{1}{2}$-million jet airport opened in Sioux Falls. This airport gave South Dakota the best travel facilities in its history. In 1972, floodwaters swept across Rapid City and the surrounding area after heavy rains caused Rapid City's Canyon Lake Dam to burst. The flood killed more than 200 persons and caused an estimated $100 million in damage.

In 1973, national attention focused on a take-over of the village of Wounded Knee by about 200 armed Indians. The seizure was designed to protest federal policies concerning Indians, and was also the result of a tribal dispute among the Oglala Sioux. During the occupation, several gunfights broke out between the occupiers and federal authorities. The occupation lasted 71 days and resulted in 2 deaths and over 300 arrests. Government officials promised to study the protesters' complaints.

DUNCAN J. MCGREGOR, EVERETT W. STERLING, and ANSON ANDERS YEAGER, SR.

SOUTH DAKOTA / *Study Aids*

Related Articles in WORLD BOOK include:

BIOGRAPHIES

Beadle, William H. H.
Calamity Jane
Crazy Horse
Custer, George A.
Deadwood Dick
Foss, Joseph J.
Gall
Hansen, Alvin H.
Hickok, Wild Bill
La Vérendrye, Sieur de
Lawrence, Ernest O.
McGovern, George S.
Mundt, Karl E.
Sitting Bull
Spotted Tail
Ward, Joseph

CITIES

Aberdeen
Lead
Pierre
Rapid City
Sioux Falls
Yankton

HISTORY

Indian Wars
Lewis and Clark Expedition
Louisiana Purchase
Missouri River Basin Project
Sioux Indians
Western Frontier Life

PHYSICAL FEATURES

Badlands
Belle Fourche Dam
Black Hills
Fort Randall Dam
Great Plains
Minnesota River
Missouri River
Oahe Dam

PRODUCTS

For South Dakota's rank among the states in production, see:

Alfalfa
Building Stone
Cattle
Flax
Gold
Honey
Oats
Rye
Sheep
Wool (graph)

Outline

I. Government
- A. Constitution
- B. Executive
- C. Legislature
- D. Courts
- E. Local Government
- F. Taxation
- G. Politics

II. People

III. Education
- A. Schools
- B. Libraries and Museums

IV. A Visitor's Guide
- A. Places to Visit
- B. Annual Events

V. The Land
- A. Land Regions
- B. Rivers and Lakes

VI. Climate

VII. Economy
- A. Natural Resources
- B. Agriculture
- C. Manufacturing
- D. Mining
- E. Electric Power
- F. Transportation
- G. Communication

VIII. History

Questions

What are the "Great Lakes of South Dakota"?

Why is South Dakota sometimes called the *Land of Infinite Variety?*

Why is it so important for South Dakota to expand its industry?

What part of South Dakota was covered by glaciers during the Ice Age?

Where is the nation's largest buffalo herd?

What is South Dakota's most precious natural resource? Why?

How does the Homestake Mine compare with other gold mines in the Western Hemisphere?

What was the first country to claim the region that is now South Dakota? How did the United States acquire this land?

What was the last big fight between Indians and whites on the northern plains?

What were the *black blizzards?*

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SOUTH DAKOTA, UNIVERSITY OF, is a state-supported coeducational school with campuses in Springfield and Vermillion, S. Dak. The main campus, in Vermillion, has a college of arts and sciences and a college of fine arts. It also has a graduate school and schools of business, education, law, medicine, and nursing. Courses lead to bachelor's, master's, and doctor's degrees. The Springfield campus grants associate's and bachelor's degrees. The University of South Dakota was founded in 1882. For the enrollment, see UNIVERSITIES AND COLLEGES (table). RICHARD L. BOWEN

SOUTH DAKOTA SCHOOL OF MINES AND TECHNOLOGY. See UNIVERSITIES AND COLLEGES (table).

SOUTH DAKOTA STATE UNIVERSITY is a state-controlled, coeducational, technological college in Brookings, S. Dak. It is a land grant school, and offers courses in agriculture, engineering, home economics, pharmacy, nursing, chemistry, journalism, and science and the applied arts. It was founded in 1881. For the enrollment of South Dakota State University, see UNIVERSITIES AND COLLEGES (table). H. M. BRIGGS

SOUTH EQUATORIAL CURRENT. See OCEAN (map: Major Ocean Currents).

SOUTH FLORIDA, UNIVERSITY OF. See UNIVERSITIES AND COLLEGES (table).

SOUTH GATE, Calif. (pop. 56,909), is a manufacturing city 8 miles (13 kilometers) southeast of Los Angeles. Products include automobiles, containers, and pipe, and rubber, cork, fiberboard, and gypsum products. South Gate was established in 1917 and incorporated as a city

in 1923. It has a mayor-council government. For location, see CALIFORNIA (political map). GEORGE SHAFTEL

SOUTH GEORGIA. See FALKLAND ISLANDS (Dependencies); ATLANTIC OCEAN (map).

SOUTH ISLAND. See NEW ZEALAND (The South Island).

SOUTH KOREA. See KOREA.

SOUTH MAGNETIC POLE. See EARTH (The Earth's Magnetism); SOUTH POLE.

SOUTH ORKNEY ISLANDS. See FALKLAND ISLANDS (Dependencies); ATLANTIC OCEAN (map).

SOUTH PLATTE RIVER. See COLORADO (Rivers).

SOUTH POLE is a term used for several invisible surface points in the Antarctic region. The best known is the *south geographic pole*. But other important south poles include the *instantaneous south pole*, the *south pole of balance*, the *south magnetic pole*, and the *geomagnetic south pole*.

The South Geographic Pole lies near the center of Antarctica at the point where all the earth's lines of longitude meet. Explorer Roald Amundsen of Norway beat Robert Scott of England to the south geographic pole in 1911 by one month. In 1956, the United States established a permanent scientific base at the pole called the Amundsen-Scott South Pole Station.

The Instantaneous South Pole lies at the point where the earth's *axis* (an imaginary line through the earth) meets the surface. The earth wobbles slowly as it turns on its axis, causing the instantaneous south pole to move. This pole takes about 14 months to move counterclockwise around an irregular path called the *Chandler circle*. The diameter of this circle varies from less than 1 foot (30 centimeters) to about 70 feet (21 meters).

The South Pole of Balance lies at the center of the Chandler circle. Its position locates the south geographic pole. The south pole of balance has moved about 6 inches (15 centimeters) toward Australia each year since 1900.

The South Magnetic Pole is the point toward which south-seeking compass needles point. This pole may move as much as 5 miles (8 kilometers) in a year. In 1970, the south magnetic pole was in Wilkes Land, in Antarctica.

The Geomagnetic South Pole lies about 900 miles (1,400 kilometers) from the south geographic pole, toward Vincennes Bay. In the upper atmosphere, the magnetic field of the earth is directed upward and away from this point. PAUL A. SIPLE

Related Articles in WORLD BOOK include:

Amundsen, Roald	Exploration and Discovery (Polar Exploration)
Antarctica (Exploration)	Scott, Robert F.
Byrd, Richard E.	Siple, Paul A.
Earth (Earth's Magnetism)	

SOUTH SANDWICH ISLANDS. See FALKLAND ISLANDS (Dependencies); ATLANTIC OCEAN (map).

SOUTH SEA. See BALBOA, VASCO NÚÑEZ DE.

SOUTH SEA BUBBLE. See GEORGE (I) of England; WALPOLE (Sir Robert).

SOUTH SEA COMPANY. See WALPOLE (Sir Robert).

SOUTH SEA ISLANDS. See PACIFIC ISLANDS.

SOUTH SHETLAND ISLANDS. See FALKLAND ISLANDS (Dependencies); ATLANTIC OCEAN (map).

SOUTH VIETNAM. See VIETNAM.

SOUTH WEST AFRICA is the territory formerly known as German Southwest Africa. The League of Nations placed it under the control of South Africa after World War I. The United Nations now calls the territory *Namibia*. South West Africa covers 318,261 square miles (824,292 square kilometers). On its borders are Angola to the north, Botswana to the east, South Africa to the south, and the Atlantic Ocean to the west. Windhoek is the territory's capital.

The Land and Its Resources. South West Africa is a dry country. The only important rivers, the Kunene and the Orange, form the northern and southern boundaries, respectively. The coastal desert area, called the *Namib*, is from 60 to 100 miles (97 to 160 kilometers) wide. Except for coastal towns, it is practically uninhabitable. Walvis Bay is the only important port.

Inland from the Namib lies the region called *Namaqualand*, which is higher and receives more rain. Poor grass and scrub vegetation cover it. Underground water is available in places. Northern Namaqualand receives sufficient rainfall to support grasses for cattle and wild game such as gazelle.

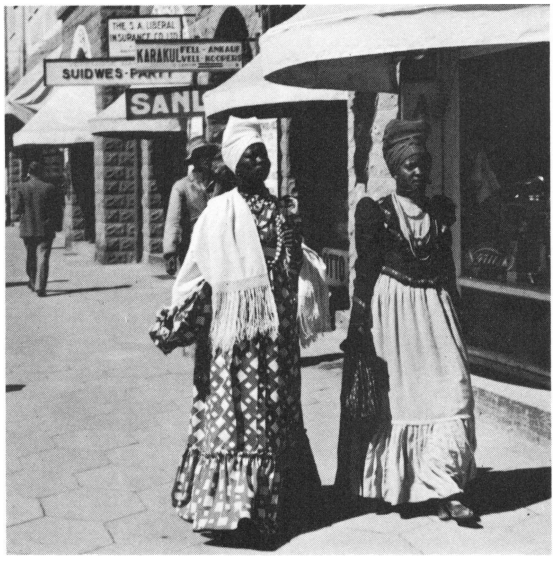
Ovamboland occupies northern South West Africa. Its dry land of rough bushes, coarse grass, and thorn trees supports some dry farming and livestock-raising. The *Kalahari*, a desert region, lies to the east. The central part of South West Africa is called *Damaraland*.

Diamonds and copper are the important mineral deposits in South West Africa. Diamonds are obtained from the gravel of the Orange River and the coast, and by large-scale dredging of the Atlantic Ocean floor.

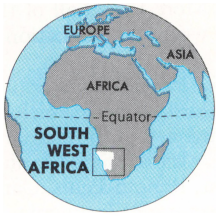
The People and Their Work. South West Africa has a population of about 928,000 people. Bushmen and Ovambos live in Ovamboland. Most of the Europeans live in northern Namaqualand, and run cattle ranches and farms. Hereros, Hottentots, and Ovambos live in Namaqualand. The Hereros were warlike, cattle-raising

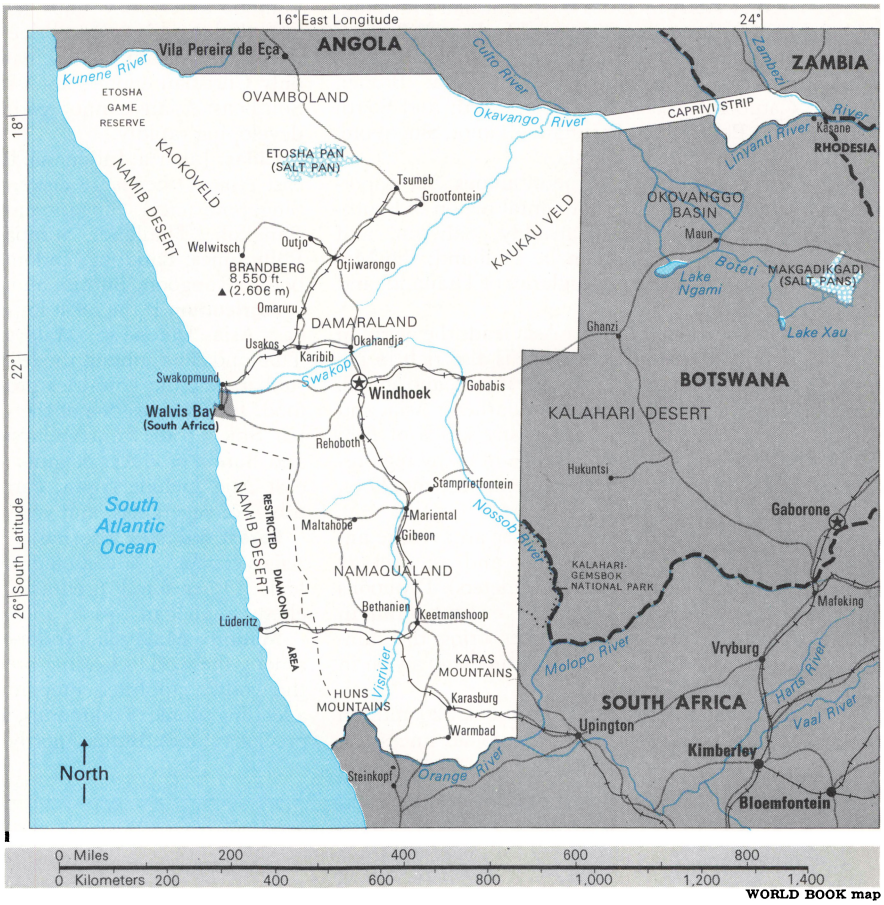
Herero Women Shop in Windhoek, the territorial capital, *below.* **Most Herero tribesmen are cattle raisers in the interior.**

South African Information Service



SOUTH WEST AFRICA





Capital
Other City or Town
Road
Rail Line
MOUNTAIN
River

WORLD BOOK map

nomads. They ruled most of the territory when the first Europeans arrived. The Rehoboths, of mixed African and European ancestry, are an important group. All these peoples—except the Bushmen—farm, raise cattle, or work in mines, on railroads, and for the Europeans.

Government. South West Africa is governed by South Africa. Its government consists of an administrator appointed by South Africa and an 18-member elected Legislative Assembly. It also sends six delegates and four senators to the South African parliament.

History. In 1883, a German company set up a trading post in South West Africa at Lüderitz. Germany annexed the area in 1884. During World War I, South African troops drove out the Germans. The League of Nations mandated the territory to South Africa in 1920.

In 1946, South Africa applied to the United Nations to annex South West Africa. The UN turned down the application and asked South Africa to place the territory under UN trusteeship. South Africa denied that the UN had any jurisdiction, and rejected the request.

Since 1961, the UN has sought South West Africa's independence. In 1966 and 1967, the UN voted to end South Africa's mandate and set up a commission to try to bring South West Africa under UN control.

The International Court of Justice ruled in 1950 that South Africa's mandate in South West Africa was legal, but that South Africa must submit annual reports of its administration to the UN. South Africa has not submitted these reports. In 1960, Ethiopia and Liberia asked the court to rule that South Africa's practice of *apartheid* (complete separation of races) in South West Africa violates its mandate. In 1966, the court rejected the case. In 1971, the court reversed its 1950 position and ruled that South Africa's control over South West Africa was illegal. South Africa rejected the court's ruling.

HIBBERD V. B. KLINE, JR.

See also KALAHARI DESERT; WINDHOEK.

SOUTHAMPTON, *sou THAMP tuhn* (pop. 213,710), is England's leading ocean passenger port. It lies near the head of Southampton Water on the Channel coast, north of the Isle of Wight. See GREAT BRITAIN (map). The island shelters Southampton's harbor, which has the advantage of tides twice a day. The city's piers and dry dock can service the largest ocean steamers. The *Mayflower* sailed from Southampton in 1620. Southampton University was founded in 1952.

JOHN W. WEBB

SOUTHAMPTON ISLAND is an ice-covered island in Canada's Northwest Territories. It lies in northern Hudson Bay. It is 210 miles (338 kilometers) long and 150 miles (241 kilometers) wide, and covers 15,913 square miles (41,214 square kilometers). About 350 persons live on the island. See CANADA (physical map).

SOUTHEAST ASIA

SOUTHEAST ASIA includes the peninsular projection of Asia and the islands that lie east of India and Bangladesh and south of China. Most people consider that the following areas make up Southeast Asia: Brunei, Burma, Cambodia, Laos, Malaysia, North and South Vietnam, the Philippines, Portuguese Timor, Singapore, Thailand and most of Indonesia.

Much of Southeast Asia is mountainous. Six important rivers cut through the continental region of Southeast Asia. They are the Irrawaddy, Salween, and Sittang in Burma; the Menam in Thailand; the Mekong on the north and east boundaries of Thailand; and the Red in Vietnam.

Natural Resources. Southeast Asia leads the world in the production of natural rubber. It is also rich in petroleum and other minerals, precious stones, and spices. Rich forests cover the mountains of Southeast Asia, and the coastal waters abound with many kinds of fish. Tropical plants support much wildlife in many regions. Such animals as boars, carabaos, elephants, monkeys, panthers, and tigers live in various areas.

Climate. Most of Southeast Asia has an average annual temperature of 80° F. (27° C), and an average annual rainfall of 40 inches (100 centimeters). Typhoons and monsoons frequently increase the amount of rain in Southeast Asia. Monsoons sometimes bring the rainfall to as much as 200 inches (500 centimeters) a year in some places.

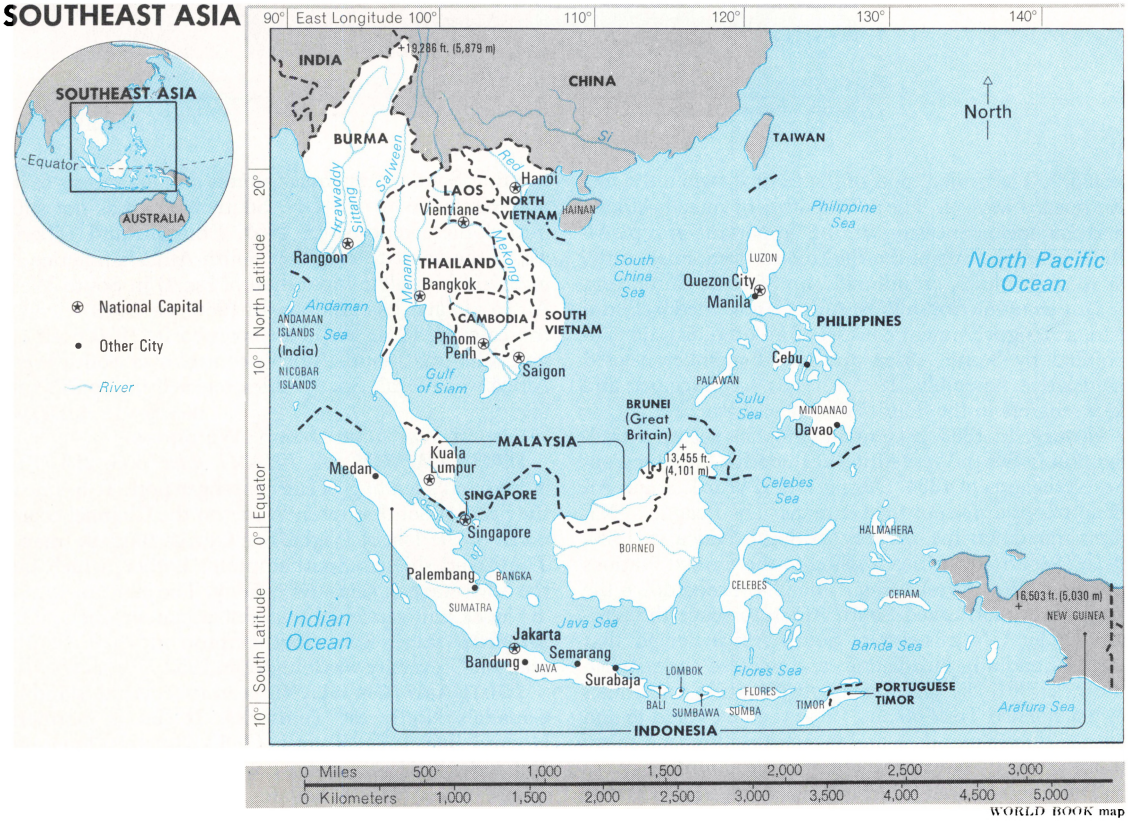
The People. Southeast Asia has about 320 million people. Most mainlanders have Mongoloid ancestors. The islanders are descended chiefly from Malay peoples. Many Southeast Asians live in small villages of wood or bamboo huts. They enjoy religious festivals and have beautiful temples and shrines. Tribal religions, Buddhism, and Islam predominate. The Philippines is the only Christian country in Asia. More than half of the Southeast Asians cannot read or write, but education is developing rapidly.

Cities. Jakarta, Indonesia, is the largest city in Southeast Asia. Other large cities, in order of size, include Singapore (city), Singapore; Saigon, South Vietnam; Bangkok, Thailand; Surabaja, Indonesia; Manila, Philippines; Bandung, Indonesia; Phnom Penh, Cambodia; Rangoon, Burma; and Semarang, Indonesia.

Agriculture is the most important industry in Southeast Asia. Indonesia, Malaysia, the Philippines, and Thailand rank among the leading producers of natural rubber. All the countries grow rice, the area's main food. Indonesia is one of the world's chief producers of tea. Spices come from Malaysia and parts of Indonesia, and Burma produces peanuts. Other products of Southeast Asia include copra, corn, livestock, sugar cane, tobacco, vegetables, and vegetable oils.

Forest Industry also has a major part in Southeast Asia's economy. The area produces most of the world's teak. Other forest products include bamboo, cedar, ebony, mahogany, pine, and sandalwood.

Mining. Malaysia, Indonesia, and Thailand are among the world's leading producers of tin. About half the world's sapphires come from Thailand. Malaysia is a leading source of diamonds, and Burma mines various precious stones. Burma, northern Borneo, and Sumatra



WORLD BOOK map

have rich petroleum deposits. The area also produces coal, copper, iron, lead, manganese, silver, and zinc.

Fishing Industry. Southeast Asians eat large quantities of seafood from the coastal waters. The catch includes anchovies, mackerel, shellfish, and tuna. The waters also provide mother-of-pearl and sponges.

Manufacturing remains largely undeveloped in Southeast Asia. But during the 1960's and early 1970's, industry began to develop rapidly in such cities as Singapore. Much of the industry centers around the processing of raw materials. Products of the region include beverages, cement, chemicals, glass, leather, rubber products, textiles, and tobacco. Craftsmen in Southeast Asia make pottery and other handicrafts.

Transportation between the regions of Southeast Asia is chiefly by sea and air. On the mainland, mountains prevent easy land transportation. Thailand and the Philippines have well-developed rail and highway systems. Manila and Singapore are important ports.

History. Europeans first entered Southeast Asia in the 1500's. Portuguese forces captured Melaka in Malaya in 1511, and Spain gained control of the Philippines in the late 1500's. Beginning in the 1600's, the Dutch gradually took over the islands that make up Indonesia. Great Britain began ruling Burma, Singapore, and most of present-day Malaysia during the 1800's. During the late 1800's, France took over Indochina, an area that is now Cambodia, Laos, and North and South Vietnam. The United States acquired the Philippines from Spain after the Spanish-American War in 1898. Only Thailand escaped colonial rule.

After World War II (1939-1945), the Philippines and all the major British colonies in the area gained independence peacefully. Indonesia became independent after a four-year war against the Dutch.

At the same time, Communist groups began to work for control of many of the Southeast Asian countries. Government forces defeated Communist guerrillas in Burma, the Philippines, and what is now Malaysia.

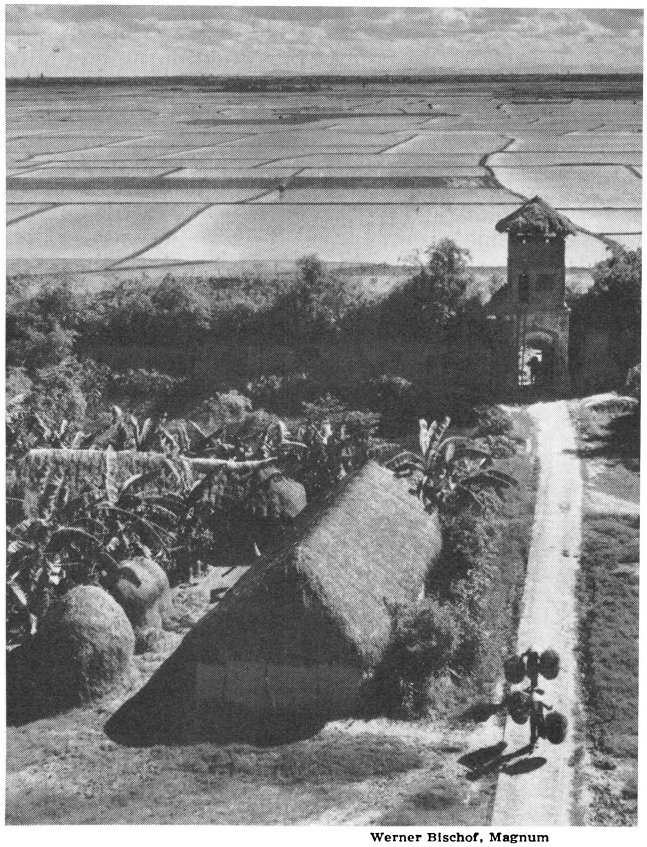
In 1946, Communist troops attacked the French in Vietnam, and fighting continued until 1954. That year, a peace agreement established Cambodia and Laos as independent neutral nations and divided Vietnam into two parts. Communists ruled North Vietnam, and South Vietnam had non-Communist leaders.

In 1957, Communist guerrillas began fighting for control of South Vietnam. Troops from South Vietnam, the United States, and other nations fought the guerrillas. The conflict spread into Cambodia and Laos. In 1973, a cease-fire agreement was reached in North and South Vietnam. That same year, Communist and non-Communist forces agreed to share control of the Laotian government. But fighting continued throughout Cambodia and in parts of South Vietnam. Communist forces conquered both countries in 1975. See VIETNAM WAR.

The Communist Party gained strength in Indonesia during the early 1960's. In 1965, a group of anti-Communist army officers seized control of the government. The army and civilian mobs killed from 200,000 to 300,000 Indonesian Communists. During the late 1960's and early 1970's, government forces battled Communist guerrillas in parts of the Philippines and Thailand.

JOHN F. CADY

See also the separate articles in WORLD BOOK for each country in Southeast Asia.

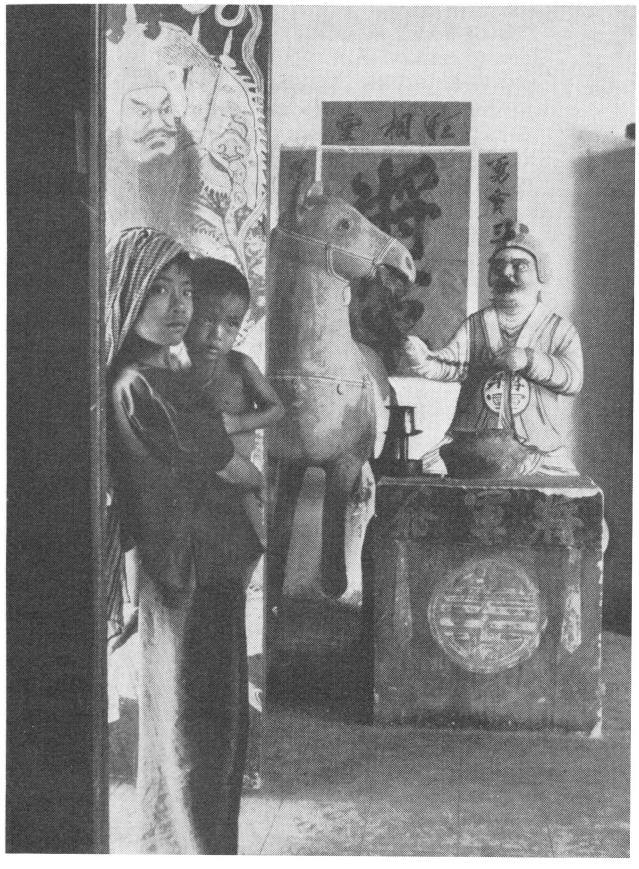


Werner Bischof, Magnum

Flooded Rice Fields surround a Vietnamese village in Southeast Asia. The tower is one of four gates to the walled village.

Oriental Paintings and Sculpture are displayed in a museum in Phnom Penh, the capital of Cambodia in Southeast Asia.

Werner Bischof, Magnum



SOUTHEAST ASIA TREATY ORGANIZATION

SOUTHEAST ASIA TREATY ORGANIZATION (SEATO) is an alliance of seven nations that signed the Southeast Asia Collective Defense Treaty in Manila, the Philippines, on Sept. 8, 1954. The members are Australia, France, Great Britain, New Zealand, the Philippines, Thailand, and the United States. Pakistan was a member until 1972, when it withdrew.

The treaty was proposed by the United States after Communist forces defeated France in Indochina (present-day Vietnam, Laos, and Cambodia). It was intended to prevent the further expansion of Communist influence in Southeast Asia. The SEATO nations agreed to help defend each other—as well as other designated nations—against military aggression in Southeast Asia. In the event of threats other than armed attack, the members agreed to "consult immediately" regarding action to be taken. The United States signed the treaty with the understanding that "aggression" meant only Communist aggression.

SEATO headquarters are in Bangkok, Thailand. The organization maintains no military forces. SEATO has a council that meets once a year, a military advisory group that meets twice a year, and a small permanent staff. Through these groups, members attempt to coordinate their defense plans for Southeast Asia.

SEATO did not develop into a strong alliance, partly because India, Indonesia, and Japan—three of the largest non-Communist nations in Asia—did not join. The SEATO members themselves divided on the extent of the Communist threat and how to meet it. Only four of the SEATO nations—the United States, Thailand, New Zealand, and Australia—sent combat troops during the 1960's when forces supported by Communist North Vietnam tried to take over South Vietnam. LUCIAN W. PYE

SOUTHEAST MISSOURI STATE UNIVERSITY. See UNIVERSITIES AND COLLEGES (table).

SOUTHEASTERN LOUISIANA UNIVERSITY. See UNIVERSITIES AND COLLEGES (table).

SOUTHEASTERN MASSACHUSETTS UNIVERSITY. See UNIVERSITIES AND COLLEGES (table).

SOUTHEASTERN STATE COLLEGE. See UNIVERSITIES AND COLLEGES (table).

SOUTHERN BAPTIST CONVENTION is the largest Baptist organization in the world. The convention has more than 34,000 churches in 50 states, but most of its members live in the South and Southwest.

The Southern Baptist Convention has 29 state conventions that operate 38 senior colleges, 15 junior colleges, 7 academies, 6 seminaries, and 4 Bible schools. The state conventions also operate hospitals, children's homes, and homes for the aging. The convention supports about 2,300 missionaries in other countries and about the same number in the United States. Many of the denomination's offices are located at 460 James Robertson Parkway, Nashville, Tenn. 37219.

The Southern Baptist Convention was organized in Augusta, Ga., in 1845, after a split among the country's Baptists over whether slaveholders should be appointed as missionaries. For more information about Baptist doctrine and history, see BAPTISTS. For the convention's membership in the United States, see RELIGION (table).

Critically reviewed by the SOUTHERN BAPTIST CONVENTION

SOUTHERN BAPTIST THEOLOGICAL SEMINARY. See UNIVERSITIES AND COLLEGES (table).

SOUTHERN CALIFORNIA, UNIVERSITY OF, is a coeducational private university in Los Angeles. It is the largest private university in the western United States. The university grants degrees in architecture and fine arts; business administration; dentistry; education; engineering; international relations; journalism; law; letters, arts, and sciences; library science; medicine; music; performing arts; pharmacy; philosophy; public administration; religion; and social work. It has a full graduate program, a summer session, and evening and extension programs. The university has Air Force and Naval Reserve Officers Training Corps programs.

The university conducts major research programs in many fields. It is especially famous for its science, engineering, and world affairs programs and facilities. The university operates a center on Catalina Island for studying marine biology, and it has a materials science center and an international and public affairs center on its Los Angeles campus.

The University of Southern California was founded in 1880. Its School of Music is housed in a building that was constructed in 1880. It is the oldest university building in southern California. For enrollment, see UNIVERSITIES AND COLLEGES (table). NORMAN TOPPING

SOUTHERN CALIFORNIA COLLEGE. See UNIVERSITIES AND COLLEGES (table).

SOUTHERN CALIFORNIA SCHOOL OF THEOLOGY. See UNIVERSITIES AND COLLEGES (table).

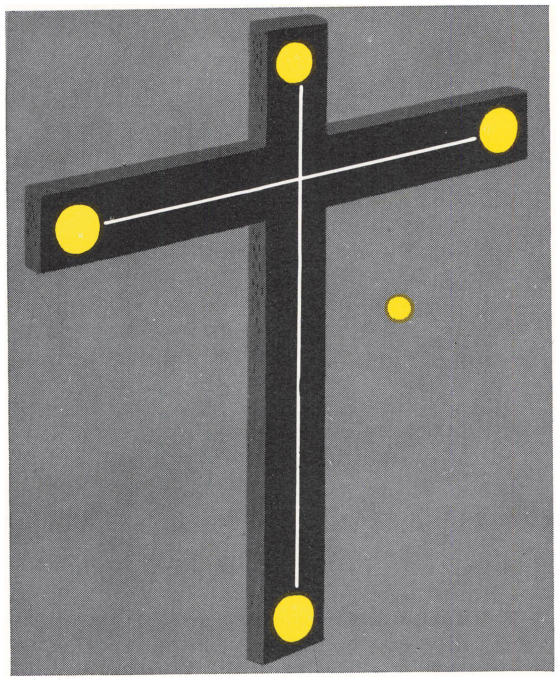
SOUTHERN CHRISTIAN LEADERSHIP CONFERENCE (SCLC) is a civil rights organization in the United States. It works to gain equal rights for black Americans and other minority groups through nonviolent civil protest and community development programs. Most SCLC affiliates are church and civil rights groups. Staff membership is open to all, but most SCLC leaders are black Protestant ministers. The SCLC is financed by contributions from individuals and organizations, and by grants from foundations.

Martin Luther King, Jr., and other civil rights leaders founded SCLC in 1957 to coordinate civil rights work in the South. King headed SCLC from 1957 until his assassination in 1968. Ralph D. Abernathy followed King as president. Headquarters are at 334 Auburn Avenue N.E., Atlanta, Ga. 30303. C. ERIC LINCOLN

See also KING, MARTIN LUTHER, JR.; ABERNATHY, RALPH D.; JACKSON, JESSE L.

The U.S.C. Campus lies about three miles southwest of downtown Los Angeles. The campus covers 95 acres (38 hectares).

SC Photo



The Southern Cross Is Seen Below the Equator.

SOUTHERN CIRCLE. See TROPIC OF CAPRICORN.

SOUTHERN COLLEGE OF OPTOMETRY. See UNIVERSITIES AND COLLEGES (table).

SOUTHERN COLORADO STATE COLLEGE. See UNIVERSITIES AND COLLEGES (table).

SOUTHERN CONNECTICUT STATE COLLEGE. See UNIVERSITIES AND COLLEGES (table).

SOUTHERN CROSS is a famous *constellation* (group of stars) in the Southern Hemisphere. It is also called the *Crux*, which is Latin for *cross*. The constellation gets its name from the outline of a cross formed by its four brightest stars. The star farthest to the south is a star of the first magnitude. The eastern and northern stars are of the second magnitude, and the western star is of the third magnitude. The four stars are not arranged in the exact form of a cross, and the constellation is sometimes difficult to pick out if one has not seen it before. The upper and lower stars, which form the "upright" of the cross, point to the South Pole of the sky.

The Southern Cross appears too far south to be seen in the United States, except for a few places. It was visible in ancient Babylonia and Greece, where people considered it a part of the constellation Centaurus (see CENTAURUS). The cross has gradually shifted southward in the sky as a result of the earth's *precession* (circular motion of the earth's axis). I. M. LEVITT

SOUTHERN EDUCATION FOUNDATION is an organization that works to improve the educational conditions of Negroes in the southern United States. In 1937, the foundation was formed from the funds of George Peabody, John F. Slater, and Anna T. Jeanes. In 1938, the Virginia Randolph fund was added. The foundation has headquarters at 811 Cypress Street N.E., Atlanta, Ga. 30308.

Critically reviewed by the SOUTHERN EDUCATION FOUNDATION

See also PEABODY EDUCATION FUND.

SOUTHERN HEMISPHERE. See HEMISPHERE; SEASON (with diagram).

SOUTHERN ILLINOIS UNIVERSITY is a state-supported, coeducational university with campuses in Carbondale and Edwardsville, Ill.

The Carbondale campus grants bachelor's, master's, and doctor's degrees. It has colleges of education and liberal arts and sciences, and schools of agriculture, business, communications, fine arts, home economics, and technology. The Edwardsville campus grants bachelor's, and master's degrees. It has divisions of business, education, fine arts, humanities, nursing, science and technology, and social sciences. It also offers courses in Alton and East St. Louis.

The university was founded in 1869, and became a four-year school in 1907. The Edwardsville campus was established in 1957. For enrollments, see UNIVERSITIES AND COLLEGES (table). DELYTE W. MORRIS

SOUTHERN MAGNOLIA. See MAGNOLIA.

SOUTHERN METHODIST UNIVERSITY is a private coeducational school in Dallas. It has schools of the arts, business administration, continuing education, humanities and sciences, law, and theology, and an institute of technology. The university grants bachelor's, master's, and doctor's degrees.

The university was founded in 1911 by the United Methodist Church. It opened in 1915. For enrollment, see UNIVERSITIES AND COLLEGES (table). PAUL HARDIN

SOUTHERN MISSIONARY COLLEGE. See UNIVERSITIES AND COLLEGES (table).

SOUTHERN MISSISSIPPI, UNIVERSITY OF. See UNIVERSITIES AND COLLEGES (table).

SOUTHERN OREGON COLLEGE. See UNIVERSITIES AND COLLEGES (table).

SOUTHERN PACIFIC COMPANY. See RAILROAD (Leading Railroad Companies).

SOUTHERN RED LILY. See LILY.

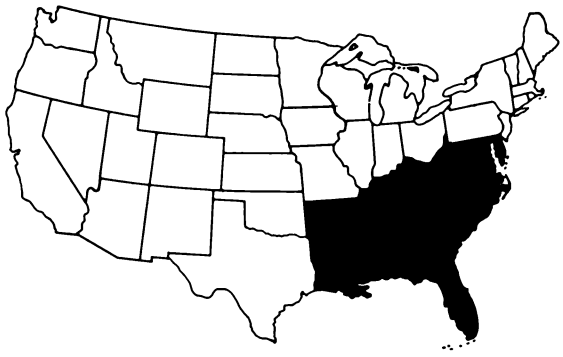
SOUTHERN RHODESIA. See RHODESIA (History).

SOUTHERN STATE COLLEGE. See UNIVERSITIES AND COLLEGES (table).

Southern Methodist University

Southern Methodist's central quadrangle has many crisscrossed walks leading to important campus buildings. The dome-topped Dallas Hall faces the quadrangle.

SOUTHERN STATES



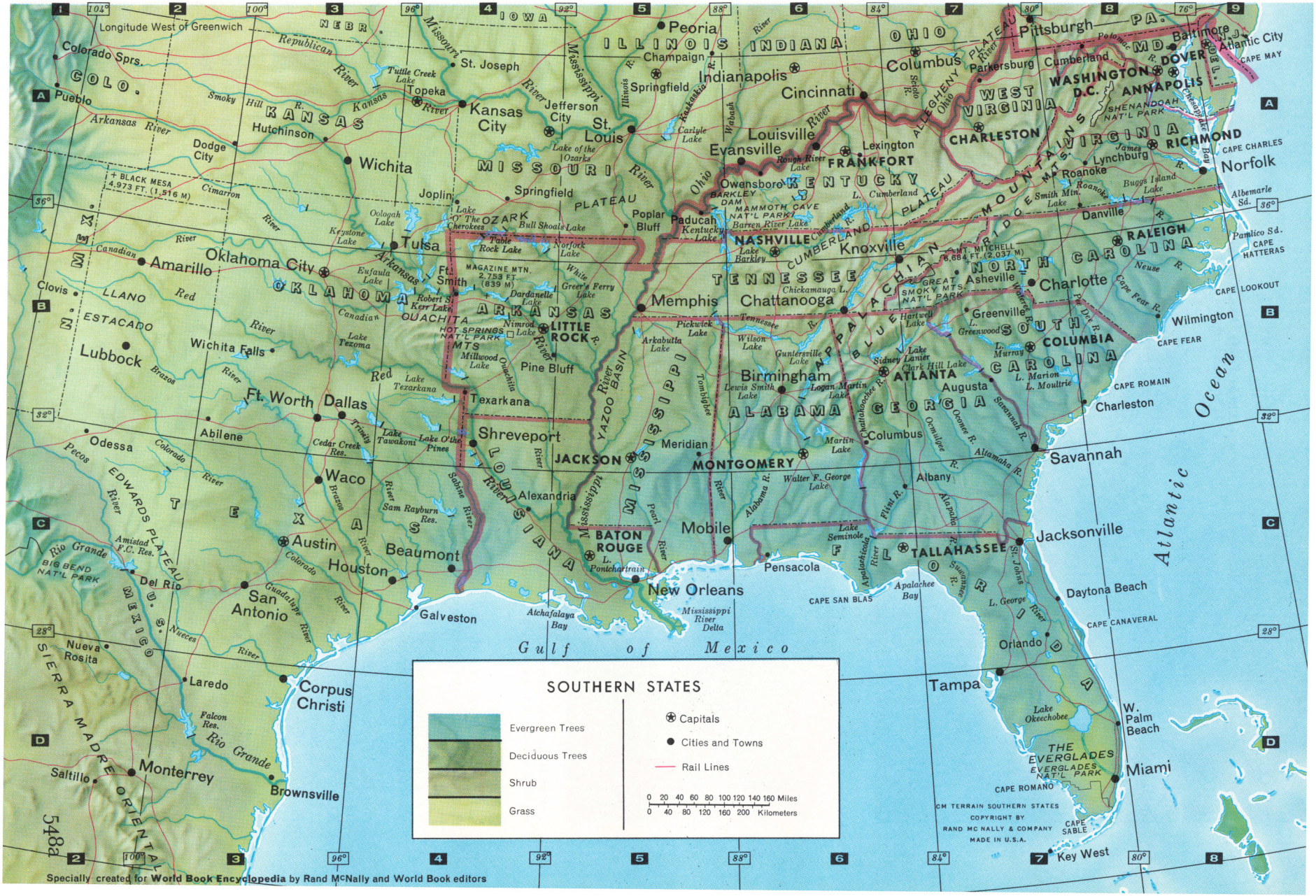
SOUTHERN STATES make up a region in the southeastern United States. They cover about a seventh of the country. Less than one-fourth of the American people live in the region. The Southern States are Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia.

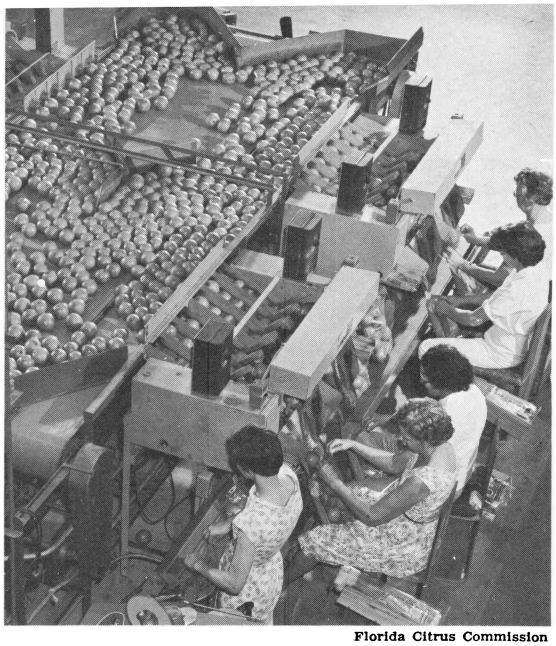
Before the Civil War, most of the South's income came from cotton, tobacco, sugar, rice, and other crops. Cotton dominated the life of Southerners living in Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina, and parts of Arkansas and Tennessee. This area is known as "the Deep South." Delaware, Kentucky, Maryland, and West Virginia are often called "border states," because they lie between the North and the Deep South.

The Civil War was fought almost entirely on Southern soil, and much of the South lay in ruins when the fighting ended. By the early 1900's, many manufacturing industries had been attracted by the wealth of raw materials and labor in the South. These industries built thousands of factories during World Wars I and II. Today, the region receives most of its income from manufacturing, mainly from chemicals, textiles, furniture, and food processing.

Gently rolling hills cover much of the South. Sandy beaches stretch along the coastal plain. Large forests of pines and other trees spread over about half of the region. They supply all the nation's turpentine and rosins; about half the wood pulp, paper, and board production; and over a fourth of its lumber. The South has over a third of the country's *bituminous* (soft) coal. Huge iron-ore deposits in the Appalachian Ridge

Many Steamboats Once Glided Along The Mississippi River, past riverbanks lined by trees draped with Spanish moss.


SOUTHERN STATES
Evergreen Trees
Deciduous Trees
Shrub
Grass
Capitals
Cities and Towns
Rail Lines
0 20 40 60 80 100 120 140 160 Miles
0 40 80 120 160 200 Kilometers
Longitude West of Greenwich
Gulf of Mexico
Atlantic Ocean
Peoria
Champaign
Springfield
Indianapolis
Cincinnati
Pittsburgh
Columbus
Parkersburg
Cumberland
Baltimore
Atlantic City
CAPE MAY
DOVER
WASHINGTON D.C.
ANNAPOLIS
SHENANDOAH NAT'L PARK
CHARLESTON
RICHMOND
CAPE CHARLES
Norfolk
Lynchburg
Roanoke
Danville
RALEIGH
Albemarle Sd.
Pamlico Sd.
CAPE HATTERAS
CAPE LOOKOUT
Wilmington
CAPE FEAR
Charlotte
Asheville
Greenville
COLUMBIA
Charleston
CAPE ROMAIN
Savannah
Augusta
ATLANTA
Columbus
Albany
Jacksonville
TALLAHASSEE
Daytona Beach
CAPE CANAVERAL
Orlando
Tampa
W. Palm Beach
Miami
CAPE ROMANO
CAPE SABLE
Key West
Pensacola
Mobile
BATON ROUGE
New Orleans
Meridian
JACKSON
MONTGOMERY
Birmingham
Chattanooga
Knoxville
NASHVILLE
Louisville
Evansville
Lexington
FRANKFORT
Owensboro
Paducah
Memphis
Springfield
Joplin
Kansas City
St. Louis
Jefferson City
Topeka
St. Joseph
Wichita
Hutchinson
Dodge City
Pueblo
Colorado Sprs.
Amarillo
Oklahoma City
Tulsa
Fort Smith
LITTLE ROCK
HOT SPRINGS NAT'L PARK
Pine Bluff
Texarkana
Shreveport
Dallas
Fort Worth
Wichita Falls
Lubbock
Clovis
Abilene
Odessa
Waco
Austin
Houston
Beaumont
Galveston
Del Rio
San Antonio
Laredo
Corpus Christi
Brownsville
Nueva Rosita
Saltillo
Monterrey
Alexandria
Baton Rouge
Lake Okeechobee
THE EVERGLADES
EVERGLADES NAT'L PARK
Apalachicola
Apalachee Bay
Atchafalaya Bay
Mississippi River Delta
CAPE SAN BLAS
Walter F. George Lake
Lake Seminole
Martin Lake
Lake Sidney Lanier
Clark Hill Lake
L. Marion
L. Moultrie
L. Murray
L. Greenwood
Hartwell Lake
Lake Keowee
Lake Jocassee
Lake Tawakoni
Lake O' the Pines
Cedar Creek Res.
Sam Rayburn Res.
Falcon Res.
Amistad F.C. Res.
BIG BEND NAT'L PARK
Lake Texoma
Lake Eufaula
Lake Oologah
Keystone Lake
Table Rock Lake
Norfork Lake
Bull Shoals Lake
Lake of the Ozarks
Lake O' The Cherokees
Robert S. Kerr Lake
Dardanelle Lake
Greer's Ferry Lake
Nimrod Lake
Millwood Lake
Lake Texarkana
Arkabutla Lake
Pickwick Lake
Wilson Lake
Guntersville Lake
Lewis Smith Lake
Logan Martin Lake
Lake Martin
Barkley Lake
Kentucky Lake
Barren River Lake
Rough River Lake
Carlyle Lake
Lake Shelbyville
Lake Cumberland
Smith Mtn. Lake
Buggs Island Lake
Roanoke
Greenville
Lake Murray
Lake Marion
Lake Moultrie
Lake Greenwood
Lake Hartwell
Lake Keowee
Lake Jocassee
Lake Sidney Lanier
Clark Hill Lake

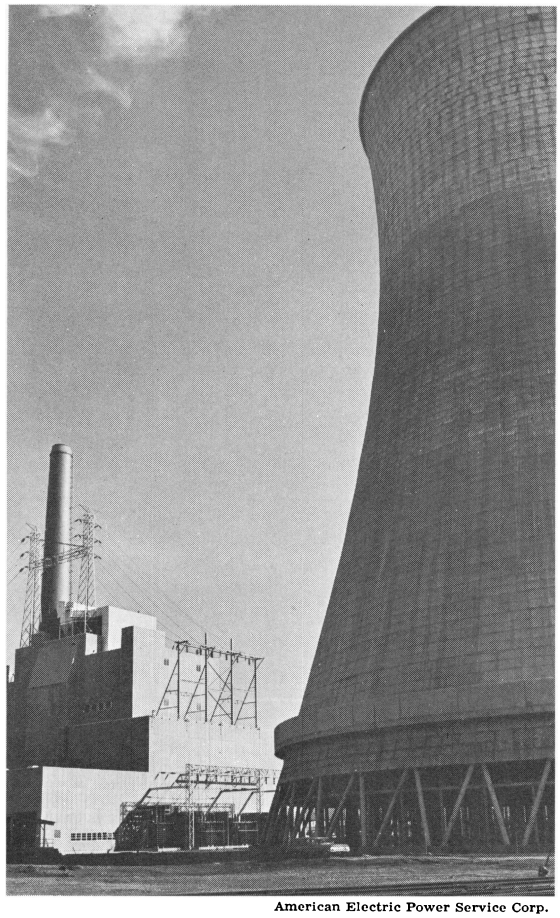


Florida Citrus Commission

Citrus Fruits, Peaches, and Apples are raised in Southern orchards for U.S. markets.

Rod Heinrichs, Grant Heilman

Cotton Is the Chief Farm Crop in the South. Six of the leading cotton states are in the region.



American Electric Power Service Corp.

Electric Power Plants aid industrial growth in the South. This plant is at Louisa, Ky., on the West Virginia border.

and Valley Region provide raw materials for Birmingham, one of the nation's major iron- and steel-manufacturing centers.

Southern farmers harvest huge quantities of cotton, tobacco, soybeans, corn, rice, sweet potatoes, pecans, peanuts, and watermelons. Florida ranks first in the growing of oranges and grapefruit. Louisiana stands third, after Hawaii and California, in sugar production. Kentucky is world famous for its race horses.

Famous Southerners include four of the first five U.S. Presidents—George Washington, Thomas Jefferson, James Madison, and James Monroe. The fiery champion of states' rights, John C. Calhoun, served as Vice-President from 1825 to 1832. Confederate General Robert E. Lee led his outnumbered troops to victory after victory during the Civil War until finally forced to surrender. George Washington Carver, the son of Negro slaves, won world fame as a chemist who helped revolutionize farming methods through his work with peanuts, pecans, and sweet potatoes. William Faulkner, internationally known novelist, won the Nobel prize for literature in 1949. The Reverend Martin Luther King, Jr., a noted leader of the U.S. Negro civil rights movement, won the Nobel prize for peace in 1964.

The Land and Its Resources

Land Regions of the Southern States have great variety. These five regions are: (1) the Coastal Plain, (2) the Piedmont, (3) the Blue Ridge Mountains, (4) the Appalachian Ridge and Valley Region, and (5) the Appalachian Plateau.

The Coastal Plain stretches from Delaware on the Atlantic Ocean to Louisiana on the Gulf of Mexico. In some sections of this region, beaches with high sand dunes give way to marshes with thick beds of peat. Islands and sand bars lie off the coast. A smaller plain extends along the banks of the Mississippi River in Tennessee, Arkansas, Mississippi, and Louisiana. Here, farmers grow cotton, rice, and other crops.

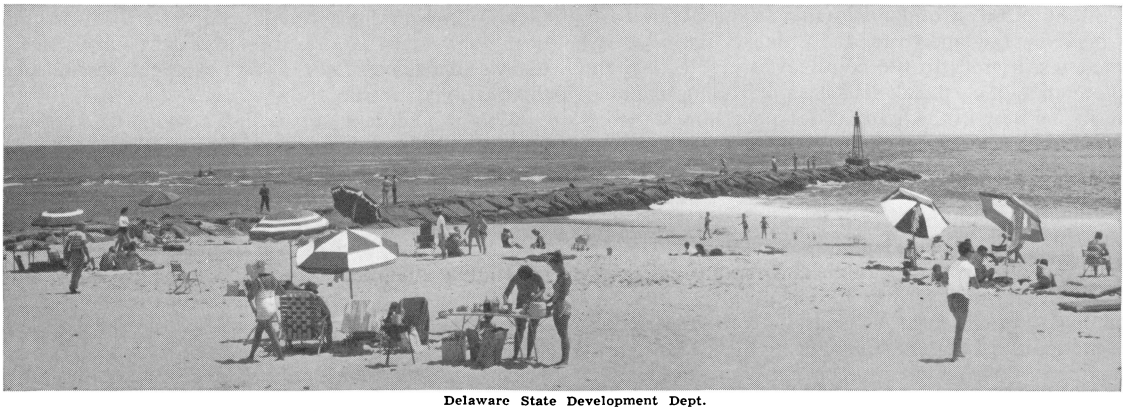
The Piedmont, an area of low hills and upland plains, extends from Delaware southwestward into Alabama. Swift streams flow southeasterly across the Piedmont. Rapids and falls provide power to generate electricity for industry. An area known as the Piedmont Industrial

North Carolina Dept. of Conservation & Development

Craftsmen in the Mountain Regions of the South make furniture and other products to sell to tourists.

Howard O. Allen

Traditional Steeplechases are held on such courses as Glenwood Race Course, near Middleburg, Va.



Delaware State Development Dept.

A Famous Vacationland, the South has beautiful, sandy beaches and recreation areas. They have become increasingly popular with people from all over the U.S.

Crescent, stretching from Virginia to east-central Alabama, has most of the South's manufacturing plants, as well as large deposits of marble, and large stands of forests. About 20 out of 100 Southerners live in the Piedmont. See PIEDMONT REGION.

The Blue Ridge Mountains, west of the Piedmont, form part of the Appalachian system. They stretch from Maryland to northern Georgia. From a distance, the forested slopes have a blue haze. The mountain area of eastern Kentucky is also part of the Appalachian system. Most of the state's coal comes from this area, where the "mountain people" live. See APPALACHIAN MOUNTAINS; BLUE RIDGE MOUNTAINS.

The Appalachian Ridge and Valley Region, between the Blue Ridge and the Appalachian Plateau, reaches from Maryland through Alabama. Rich soil covers the river valleys, which are separated by ridges and plateaus.

The Appalachian Plateau covers parts of Maryland, Virginia, West Virginia, Tennessee, and Georgia. Rivers have cut through the uplands, carving scenic gorges.

Climate of the Southern States is usually uniformly mild and humid. Extremes of temperatures occur, but only for brief periods. This mild climate helps farmers raise a large variety of field crops and pasture grasses. Average January temperatures range from 30° F. (−1° C) in West Virginia to around 67° F. (19° C) in the Miami area. In winter, vacationers from the North find the warm, sunny climate of the South a welcome relief from the cold. The tourist industry provides Florida with about half of its income. Average July temperatures range from between 75° F. (24° C) and 80° F. (27° C) along the Gulf Coast to slightly lower in the northern and central parts of the South.

The most abundant rainfall generally comes in late winter and early spring, but no season is dry. An average of about 35 inches (89 centimeters) of rain falls in northern Virginia. The Appalachian Mountains in the Asheville, N.C., area receive around 80 inches (200 centimeters) of rainfall a year.

Activities of the People

The People are mostly of English, Irish, or Scottish descent. During the early 1700's, many French settled along the coast in Mississippi and Louisiana.

SOUTHERN STATES

Large numbers of Scandinavians, Germans, Slavs, and Italians emigrated to the United States in the late 1800's and early 1900's. But they were attracted to jobs in factories in the industrial North, and did not settle in the Southern States. The white population of the South is unique in the nation, because the people have generally similar backgrounds.

Dutch traders brought Negro slaves to Virginia in 1619. Plantation slavery in America began on South Carolina rice plantations. By 1808, when Congress prohibited importation of slaves, about 450,000 had been brought into the country. After the Civil War, thousands of Negroes sought work in the North.

Until the middle 1900's, most of the South's income came from agriculture. After 1940, machines replaced thousands of farmers in the fields. Many northern industries moved south, attracted by the climate, the raw materials, and the great numbers of markets and workers. By the time World War II ended, the South had a healthy economy for the first time since the Civil War.

Manufacturing and Processing began about 1875, when New England cotton industrialists began moving their textile mills to the Southern States. Today, the production of chemicals ranks as the leading manufacturing activity in the South. Food processing is second in importance. Most manufactured products come from the Piedmont Industrial Crescent, the South's largest manufacturing area.

Chemical industries have been attracted to the Louisiana-Texas coastal plain since the early 1900's, because of its great petroleum and natural gas fields. Plants there produce over 700 chemical products, including synthetic fibers, glycols, and carbon black.

Florida and Louisiana rank among the leading sugar-producing states. A variety of cheeses comes from plants in Tennessee and Kentucky. Factories throughout the South produce cooking oils and peanut butter, as well as other processed foods. Tobacco-processing plants operate in all the Southern States.

Textile and clothing manufacturing in the Carolinas, Virginia, and Georgia employs about a fourth of the industrial workers in the South. Many clothing factories have been built since 1940, especially in small towns in Georgia and North Carolina. These plants concentrate on making sports and work clothes, shirts, and children's apparel.

Florida, Maryland, North Carolina, South Carolina, and Virginia produce about one-third of the wooden furniture sold in the United States.

Iron ore deposits in the Appalachian Ridge and Valley Region supply raw materials for the Birmingham iron and steel district.

Thousands of pine trees in southern forests yield sap, used to make turpentine sold in the United States. About one-half of the country's pulp, paper, and board; and about three-tenths of its lumber come from southern forests. The Mobile Bay area in Alabama, northern Florida, and southeastern Georgia have most of the paper and pulp mills.

Agriculture. The South has about 1,079,000 farms, more than one-third of the total in the United States. The size of the average farm in the Southern States ranges from 97 acres (39 hectares) in North Carolina to about 380 acres (154 hectares) in Florida.

Cotton ranks as the chief income-producing crop. Of the 10 leading cotton-growing states, six are in the South. The chief cotton areas include the Mississippi Valley, the Tennessee Valley in northern Alabama, the inner coastal plains in Georgia and the Carolinas, and the lower Georgia-South Carolina Piedmont.

Most American tobacco comes from the Southern States, led by North Carolina. Tobacco also grows well in Florida, Georgia, Kentucky, Maryland, South Carolina, Tennessee, and Virginia.

Alabama, Florida, Georgia, North Carolina, and Virginia rank among the leading peanut-producing states. Alabama, Georgia, and Louisiana are among the leading pecan-producing states. Louisiana, North Carolina, and Virginia grow nearly two-thirds of the country's sweet potatoes. Southern farmers also harvest corn, rice, soybeans, tomatoes, and watermelons. Florida has more than 500,000 acres (202,000 hectares) of citrus groves. Georgia and South Carolina raise large peach crops. Apples flourish in Virginia and West Virginia.

Seven of the top 10 broiler chicken states are in the South. Central Alabama and northwestern Mississippi have fine grazing land for beef and dairy cattle. Kentucky's bluegrass pastures are excellent for raising thoroughbred race horses.

Mining. Kentucky stands first among the states in coal mining. West Virginia, Alabama, Tennessee, and western Virginia also have valuable coal deposits. About 11 billion short tons (10 billion metric tons) of known iron ore reserves lie in northern Alabama, northwestern Georgia, and eastern Tennessee. Tennessee is the leading zinc producer in the United States.

The South has important petroleum reserves, especially in the Gulf coastal area. Here also are large underground deposits of sulfur and salt-bearing rock. Only Texas supplies more natural gas than Louisiana. Georgia and South Carolina produce much of the country's kaolin, a clay used in making pottery. Miners take phosphates from Tennessee and Florida. Brick clays are found in every Southern State. Georgia leads all the states in the quarrying of granite, and Tennessee is one of the leading marble-producing states.

Transportation. The South's natural harbors on the Atlantic Ocean and the Gulf of Mexico serve passenger liners and freighters from all parts of the world. Every year, thousands of tons of cargo pass through Norfolk, Va., one of the world's busiest ports. Since pioneer days, the Mississippi River has been a great natural waterway for travelers and freight.

Regional Cooperation. Worn-out soil, caused by a one-crop farming system, has been a major problem throughout the South. Until 1930, cotton or tobacco furnished the chief source of income in most farming areas. Year after year, farmers planted these crops on the best soils, gradually robbing the land of valuable minerals.

Most of the cotton and tobacco were grown by tenant farmers or sharecroppers, who rented the land from the owner. They usually received half of the income from the crop sold. But sometimes disease attacked the plants or market prices dropped, and the tenant farmer earned little. The breakup of the one-crop, share-tenant pattern began in the 1930's. The federal Agricultural Adjust-

ment Act of 1933 fixed prices for basic farm commodities at a certain level, in keeping with prices of manufactured goods. Southern farmers could then count on improved incomes every season, which had not been possible before that time. The government also restricted acreages that could be planted in cotton and tobacco. Farmers began planting many kinds of crops on the freed acres, or developed them as grazing land to feed livestock. These practices increased income.

Soil erosion also resulted from the one-crop system. Since 1945, reforestation commissions have planted vast tracts with pine trees to help anchor the soil and prevent it from being washed down hillsides.

The Tennessee Valley Authority has built 23 dams on the Tennessee River and its branches for irrigation and industry. The Southern States have also created interstate agencies to manage sanitation, transportation, and parks. Kentucky and Virginia, for example, each supply three commissioners to the Breaks Interstate Park Commission. It collects fees and issues bonds for the use and upkeep of the Breaks of the Sandy River Park, shared by both states. MERLE PRUNTY, JR.

Related Articles. See the separate article on each of the states in this region with its list of Related Articles. Other related articles include:

HISTORY AND GOVERNMENT

Border State
Carpetbagger
City Government
Civil War
Colonial Life in America
Confederate States of America
French and Indian Wars
Indian, American
Local Government
Louisiana Purchase
Mason and Dixon's Line
Negro
Pioneer Life in America
Reconstruction
Revolutionary War in America
Scalawag
State Government
States' Rights
Tennessee Valley Authority
United States, Government of the
United States, History of the

PHYSICAL FEATURES

Allegheny Mountains
Cumberland Mountains
Delaware River
Delmarva Peninsula
Delta
Dismal Swamp
Everglades
Great Smoky Mountains
Gulf of Mexico
Hampton Roads
Mississippi River
Ohio River

Outline

I. The Land and Its Resources
- A. Land Regions
- B. Climate

II. Activities of the People
- A. The People
- B. Manufacturing and Processing
- C. Agriculture
- D. Mining
- E. Transportation
- F. Regional Cooperation

Questions

When was manufacturing introduced into the South?
How did the Agricultural Adjustment Act of 1933 help raise farm income in the South?
How is the South's population unique in the country?
Where are most of the South's manufacturing plants?
What area is known as "the Deep South"?
What is the South's largest manufacturing industry?
What is the South's chief income-producing crop?

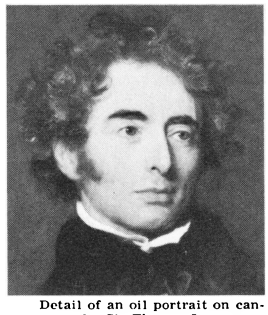
SOUTHERN UNIVERSITY is a state-supported coeducational land-grant institution in Baton Rouge, La. It has branch campuses in New Orleans and Shreveport, La. The main campus has colleges of agriculture, arts, business, education, engineering, home economics, and sciences. It also has a graduate school and law school. The university grants bachelor's and master's degrees.

Southern University was founded in New Orleans in 1880. The school moved its main campus to its present location in 1914. The school's official name is Southern University and Agricultural and Mechanical College. For the enrollment of Southern University, see UNIVERSITIES AND COLLEGES (table). G. LEON NETTERVILLE, JR.

SOUTHERN UTAH STATE COLLEGE. See UNIVERSITIES AND COLLEGES (table).

SOUTHERN YEMEN. See YEMEN (ADEN).

SOUTHEY, *SUTH ee,* **ROBERT** (1774-1843), was poet laureate of England from 1813 until his death. He is chiefly remembered for a few ballads, including "The Battle of Blenheim" (1798), and for his association with William Wordsworth and Samuel Taylor Coleridge (see LAKE POETS).



Detail of an oil portrait on canvas by Sir Thomas Lawrence; South African National Gallery, Cape Town, South Africa

Robert Southey

Critics consider Southey a better prose writer than poet. He wrote much history and biography, including the *Life of Nelson* (1813). His prose collection *The Doctor* (1834-1847) popularized the fairy tale "The Three Bears." Southey also wrote two long free verse romances, *Thalaba, the Destroyer* (1801) and *The Curse of Kehama* (1810). These works use Moslem and Hindu mythologies, and influenced several poets, including Percy Shelley and Sir Walter Scott.

Southey was born in Bristol. He and Coleridge supported ideals that inspired the American and French revolutions. They planned to establish a utopian community in the United States, but the project failed because of a lack of financial support. Southey later became conservative and supported the English monarchy. KARL KROEBER

SOUTHWEST BAPTIST COLLEGE. See UNIVERSITIES AND COLLEGES (table).

SOUTHWEST MINNESOTA STATE COLLEGE. See UNIVERSITIES AND COLLEGES (table).

SOUTHWEST MISSOURI STATE COLLEGE. See UNIVERSITIES AND COLLEGES (table).

SOUTHWEST TEXAS STATE UNIVERSITY. See UNIVERSITIES AND COLLEGES (table).

SOUTHWESTERN ARBORETUM. See ARIZONA (Places to Visit).

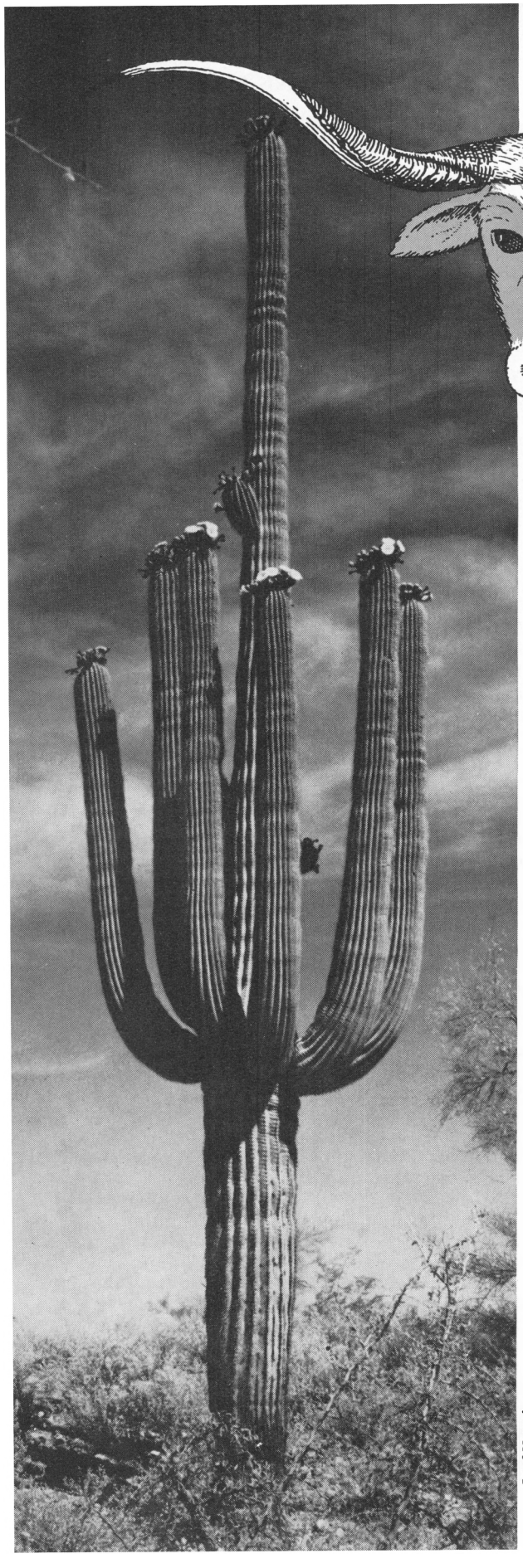
SOUTHWESTERN AT MEMPHIS. See UNIVERSITIES AND COLLEGES (table).

SOUTHWESTERN BAPTIST THEOLOGICAL SEMINARY. See UNIVERSITIES AND COLLEGES (table).

SOUTHWESTERN COLLEGE. See UNIVERSITIES AND COLLEGES (table).

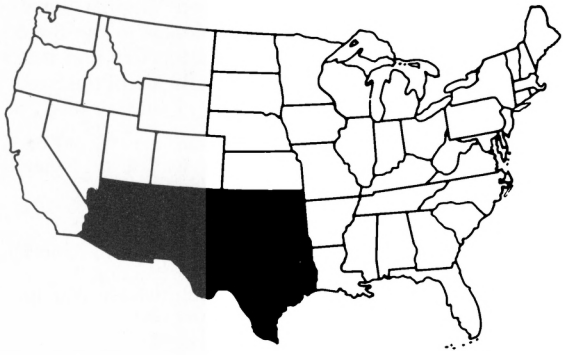
SOUTHWESTERN LOUISIANA, UNIVERSITY OF. See UNIVERSITIES AND COLLEGES (table).

SOUTHWESTERN STATE COLLEGE. See UNIVERSITIES AND COLLEGES (table).



Josef Muench

SOUTHWESTERN STATES



SOUTHWESTERN STATES are a region of wide open spaces, where travelers may go long distances without seeing a house. About a twelfth of the nation's people live in Arizona, New Mexico, Oklahoma, and Texas. But the combined area of these four states forms about a sixth of the country. Arizona and New Mexico are also considered Rocky Mountain States.

The Southwest has a magical charm that blends the ancient and the modern. Santa Fe, N.M., founded in 1610, is the oldest seat of government in the United States. Nearby, at the Los Alamos atomic research center, scientists develop and test the newest atomic devices. In remote sections of the Southwest, Navaho Indians still hunt with bows and arrows while vapor trails of jet planes streak the skies overhead. Visitors to the Southwest enjoy colorful pageants and rodeos that recall stirring tales of the Western frontier.

The economic activity of the Southwestern States centers chiefly around six C's: cattle, cotton, citrus fruits, copper, crude oil, and climate. Livestock graze on range land that stretches as far as the eye can see. Many irrigated farms and ranches produce cotton seed, alfalfa, and sorghum grains for livestock feed. Texas leads the states in the production of cotton. Great dams, including Hoover Dam on the Colorado River and Coolidge Dam on the Gila River, provide water for irrigation. Rich red soil, especially in the Rio Grande Valley, yields great quantities of oranges and grapefruit, as well as chili peppers, dates, melons, and lettuce.

Mining is one of the biggest industries in the South-

Cactus Plants Thrive In the Southwestern States. The giant, or saguaro, cactus, *left*, is one of many varieties. Longhorn cattle, *above*, developed from cattle left by the Spaniards, played a leading role in the early development of the Southwest.

CM TERRAIN SOUTHWESTERN STATES
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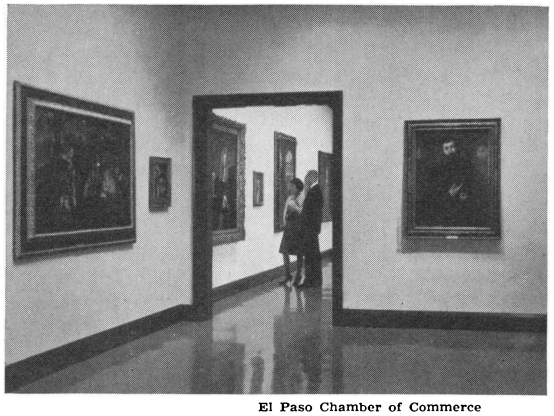
New Mexico Department of Development

The Cattle Ranches of the Southwest produce most of the nation's beef. Arizona, New Mexico, Oklahoma, and Texas also produce sheep and other livestock.

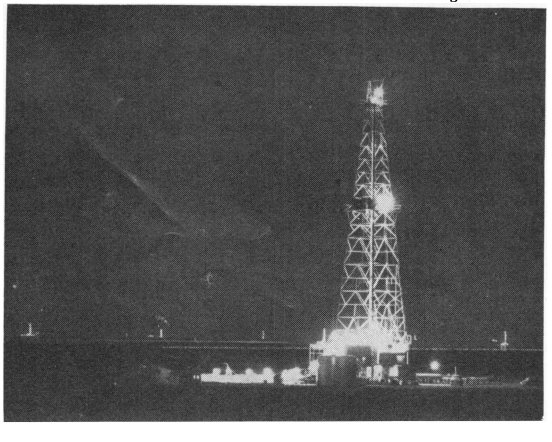


El Paso Chamber of Commerce

Cultural Life in the Southwest includes theaters and excellent museums, such as the El Paso Museum of Art.

Rich Oil Fields have produced great wealth. The Southwest is one of the world's greatest petroleum producers.

Humble Oil & Refining Co.



west. Drillers tap vast pools of petroleum and natural gas underground. Giant tanks store refined oil, and pipelines carry gas to many parts of the United States and Canada. Texas supplies about a tenth of the petroleum produced in the world.

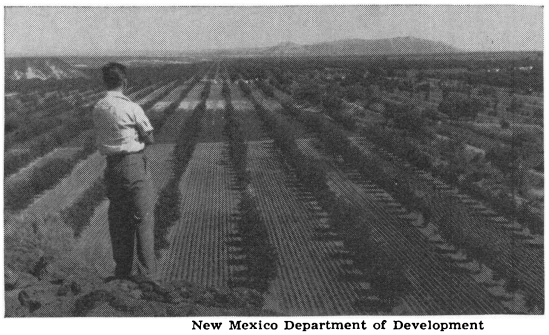
The year-round warm, dry climate attracts visitors to resorts and dude ranches scattered throughout much of the region. Cactus plants thrive in the Southwest, providing a vivid contrast between their beautiful flowers and their sharp spines. Some of the world's most spectacular sights may be seen in the region. These include the Grand Canyon, Carlsbad Caverns, and the Petrified Forest.

Prehistoric Indians lived in the Southwest as long as 25,000 years ago. Later, Cliff Dwellers built their homes high and safe in the sides of cliffs. They developed a civilization that reached its peak between A.D. 1100 and 1300. The Hopi, Zuñi, Acoma, Taos, and other Pueblo Indians who live there today are probably descendants of these early Cliff Dwellers. See CLIFF DWELLERS.

About 285,000 Indians, or about 35 per cent of the Indian population of the United States, live in the Southwestern States, mostly on reservations. Some Spanish-Americans in the region are descendants of settlers who followed the route pioneered by the expedition of Francisco Coronado in 1540.

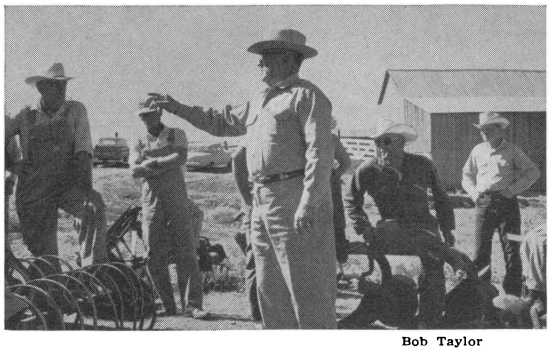
The Land and Its Resources

The Treaty of Guadalupe Hidalgo, which ended the Mexican War in 1848, fixed the boundary between Texas and Mexico at the Rio Grande. Texas, New Mexico, and Arizona lie along most of the border.



New Mexico Department of Development

Big Fruit and Vegetable Crops now grow on once-barren land. This pecan orchard is near Las Cruces, N.Mex.



Bob Taylor

Farmers in Oklahoma rank among the world's leading wheat producers. They also produce big cotton crops.

Land Regions of the Southwest include almost every kind of terrain. There are mountains, plains, steep valleys, flat valleys with alkali flats, mesas, spectacular gorges, and desert basins with no sea outlets.

The Basin and Range Region covers about a third of the Southwest. It extends from northwestern Arizona to southwestern Texas. Southwestern Arizona has both mountains and plains. The plains consist of ancient valleys that have filled with rock and soil washed down from mountains. Broad plains, mountains, and valleys characterize the region in New Mexico and Texas.

The Colorado Plateau is a vast upland area that extends across northeastern Arizona and northwestern New Mexico. Thick pine forests cover the slopes of isolated mountain ranges. Hematite, an iron-ore mineral, glows red, purple, and yellow in Arizona's Painted Desert, coloring the landscape. The country's most famous petrified forest lies near Holbrook, Ariz.

Great Plains cover eastern New Mexico and north-central Texas. Farmers plant alfalfa and other crops in New Mexico's irrigated Pecos Valley. The *Llano Estacado*, or *Staked Plains*, of western Texas stretch over a vast, dry, treeless area. The irrigated soil provides one of the richest farming belts in the region. Herds of cattle and sheep graze on grasses that cover a large plateau to the south. Mining areas yield building stone, potassium, and petroleum. Plains also spread over a wide belt running north-south through Oklahoma where farmers raise cotton and sorghums.

West Gulf Coastal Plains in Texas extend along the Gulf of Mexico. Narrow sand bars and coastal islands enclose shallow lagoons. Rice is grown in this humid, subtropical section. Dense forests of pines and cypresses cover rolling hills in the northeastern part. Petroleum and other minerals lie beneath the region's sandy soil.

Climate of the Southwestern States is generally dry, with little humidity. The driest sections, in western and northern Arizona, south-central New Mexico, and a tip of western Texas, attract vacationers and health seekers from all parts of the country. Phoenix and Tucson have long been famous winter resorts.

Average January temperatures range from about 30° F. (−1° C) in western New Mexico to about 60° F. (16° C) in the southern tip of Texas. The southern desert regions have generally warm, sunny, winter days, but night temperatures may drop to freezing. July temperatures average about 73° F. (23° C) in northeastern New Mexico, and about 85° F. (29° C) in southwestern Texas. Along the Mexican border, summer temperatures often reach 115° F. (46° C).

The average yearly rainfall varies from about 5 inches (13 centimeters) in southwestern Arizona to about 50 inches (130 centimeters) in the Beaumont-Port Arthur, Tex., area. Cloudbursts occur frequently during the summer (see CLOUDBURST). The hard, parched, desert ground cannot absorb the torrents of water quickly, and dry gullies, called *arroyos*, become flooded in a few minutes. Droughts may come in spring and fall, and blinding dust storms may blow up suddenly. The annual average snowfall ranges from 1 inch (2.5 centimeters) in the mountains of southwestern Arizona and southern Texas to about 200 inches (500 centimeters) in the north-central mountains of New Mexico.

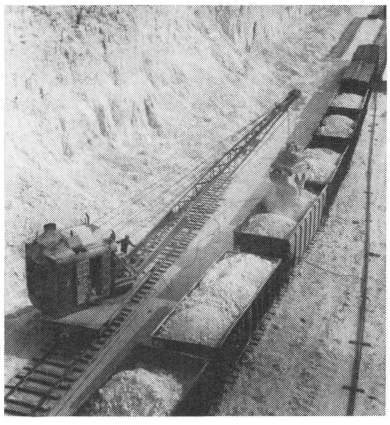
The Southwest has about 340 frost-free days in the eastern Gulf region. This year around warm weather helps farmers grow a variety of crops.

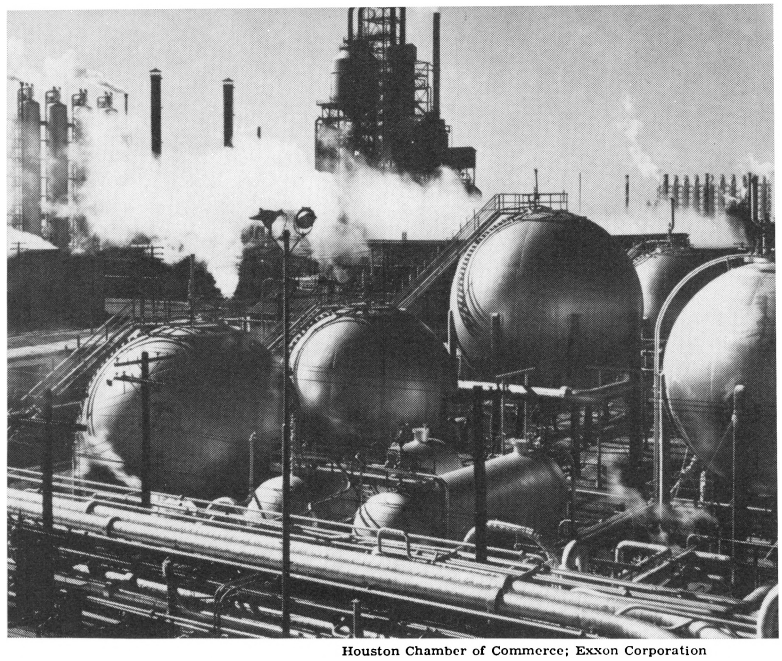
Activities of the People

The People. The first white man to enter the Southwest was a Spaniard, Alonso Álvarez de Piñeda, who explored and mapped the Gulf Coast of Texas in 1519. In 1540, Francisco Coronado, a Spanish explorer from Mexico, led an expedition into the region. In 1610, 10 years before the Pilgrims landed at Plymouth Rock, Spaniards founded Santa Fe. But Spain made little effort to colonize the vast, dry region.

Westward migration began during the 1800's. Prospectors, trappers, railroad workers, and cowboys came, seeking adventure and wealth. The United States and Mexico fought the Mexican War of 1846-1848 for control of the Southwest (see MEXICAN WAR). After the war, Mexico ceded the United States over 525,000 square miles (1,360,000 square kilometers) of land.

Today, three distinct cultures—Indian, Spanish-American, and Anglo-American—are represented among the people of the Southwestern States. American Indian tribes include the Hopi, Mohave, Navaho, Papago, Pima, and Yuma in Arizona; the Pueblo of the Rio Grande Valley of New Mexico; the Apache, Comanche, and other groups in eastern New Mexico and Texas; and the Cherokee, Cheyenne, and other groups in Oklahoma. Many Indians remain on reservations where, as herdsmen and farmers, they live much as their ancestors did hundreds of years ago. Their exquisite silver and turquoise jewelry, pottery, blankets, rugs and





The Southwest Supplies Sulfur and Gas to most of the nation. Sulfur is being put into cars for shipment, above. Tanks, *right*, hold butadiene, a gas used to make synthetic rubber.

Houston Chamber of Commerce; Exxon Corporation

other arts and crafts products are sold at hotels, curio shops, and trading posts. Many Indians in Oklahoma do not dwell on reservations, but live and work throughout the state. See INDIAN, AMERICAN (Table of Tribes).

The Spanish-Americans live mainly in small farming communities, many in secluded foothill valleys. Others make up segments of the populations of big cities. People in villages raise sheep, goats, and poultry, as well as fruits and vegetables. Spanish-American farmers grow large quantities of chili peppers. Following the autumn harvest, they hang *ristras* (strings) of the scarlet peppers over the walls of their houses and barns to cure in the hot sun. See MEXICAN AMERICANS.

Thousands of Anglo-Americans, many of whose ancestors came from Europe and Canada, work in cities and farming areas throughout the Southwest.

Mining. Texas ranks first among the mining states in production and in output of petroleum and natural gas. Oil refineries and smelters reduce some of the ore and crude oil, but much of it is shipped from the region for refining. In 1889, Edward Byrd dug a shallow oil well near Chelsea, Okla. Since then, more than 100,000 oil wells have been dug in the Red Fork-Tulsa, Glenn Pool, Cushing, and other Oklahoma fields. The first important petroleum discovery came with the exploration and drilling of the Spindletop field near Beaumont, Tex., in 1901. The famous East Texas oil field, which opened in 1930, has about 14,500 producing wells.

About two-fifths of the nation's natural gas comes from Texas. This state also supplies about one-half of the country's sulfur. Natural gas fields located in Oklahoma and Texas contain much of the world's supply of helium.

Arizona and New Mexico have huge copper and silver reserves. Miners take lead and zinc from valuable deposits in New Mexico and Arizona. Salt mining centers around the Texas cities of Grand Saline, Palestine, and Corpus Christi. New Mexico and Texas are leading uranium-ore mining states. New Mexico mines more than 12 million pounds (5.4 million kilograms) a year. Southwestern stone quarries produce building stone. Asbestos, beryllium, manganese, mica, molybdenum, and vanadium are other minerals found in this area.

Manufacturing and Processing is the largest source of income in value of production. Since World War II, many leading chemical firms have built plants in the Southwest, close to the abundant supplies of raw materials. Chemical products, including synthetic rubber and petrochemicals, rank as the leading manufactures. Chemical production centers mainly in the Texas cities of Beaumont, Brownsville, Corpus Christi, Houston, San Antonio, Texarkana, and Wichita Falls.

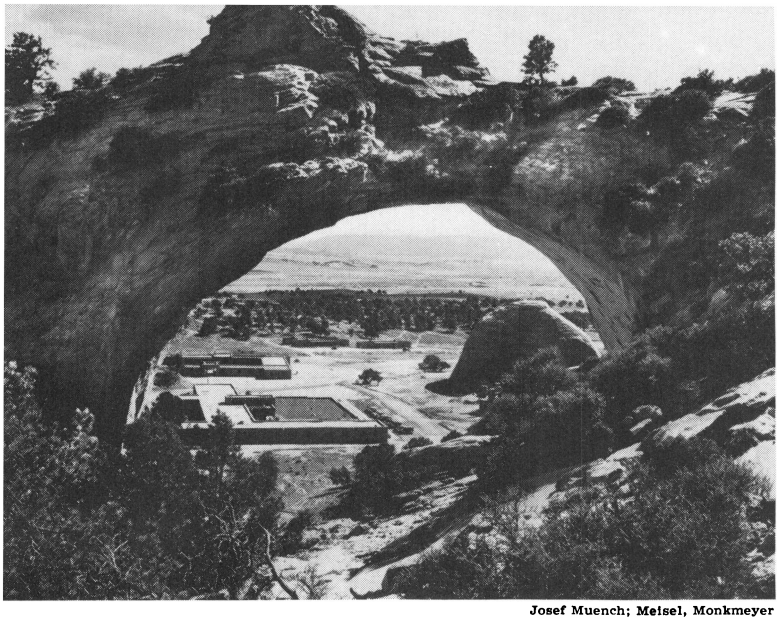
Visitors easily recognize the presence of carbon black factories in the region. The wind carries black, oily smoke from their chimneys and deposits it across the countryside, leaving plant life greasy and black. Carbon black is used as a pigment in paints and enamels, manufactured chiefly in Tucson, Tulsa, and Corpus Christi.

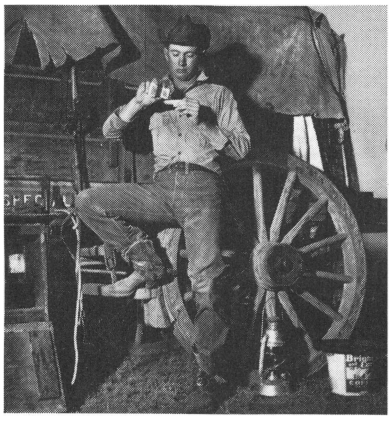
Several southwestern cities have meat-packing plants and factories that pack or process fruits and vegetables.

Almost every major oil company has petroleum refineries in the Southwest. Some of the large cities manufacture oil-field machinery and supplies, such as drilling supplies, derricks, and pipe. Furniture and other wood products made principally of ponderosa pine come from the Southwest. Other important manufactures include cotton textiles, cement and clay products, metal products, electronics equipment, and airplane parts.

During World War II, the U.S. government began developing new defense materials in New Mexico. Today, scientists conduct atomic experiments in the Los Alamos Scientific Laboratory. The Atomic Energy Commission develops and assembles atomic weapons at Albuquerque.

Agriculture. Large herds of beef and dairy cattle, sheep, and horses graze on grasslands that cover hundreds of thousands of acres. Stock raising has been an important industry in the Southwest since the early 1800's, when settlers found herds of Longhorn cattle roaming the plains. These cattle were descendants of the stock introduced by the Spaniards in the 1500's. Today, Texas stands first in the production of beef cattle, sheep and wool, and horses. Ranchers in Okla-





Window Rock Is a Natural Formation in Arizona, *left*. Through its opening, visitors see miles of open land where cowboys, such as the one shown above, ride southwestern ranges.

Josef Muench; Meisel, Monkmeyer

homa, New Mexico, and Arizona also have large livestock herds.

The famous King Ranch, the largest in Texas, covers 823,403 acres (333,219 hectares) near Kingsville, Tex. It was founded in the 1850's by Richard King, a steamboat captain. In the early 1900's, this ranch began breeding Santa Gertrudis cattle, the first distinct breed perfected in the United States.

The rewards of cotton raising brought many of the earliest settlers south of the Red River and west of the Sabine River. Cotton was first planted in the Brazos Valley during the early 1800's. Texas now leads the states in cotton production. Other leading field crops of the Southwest include alfalfa, barley, corn, flaxseed, oats, rice, rye, sorghums, and wheat. Ranchers use many field crops for winterfeeding livestock.

Farmers grow vegetables and fruits in many sections, but most of the land must be irrigated or dry farmed (see DRY FARMING). Southwestern farmers harvest large crops of pinto beans, chili peppers, lettuce, onions, sugar beets, and sweet potatoes. Texas and Arizona rank among the leading states in the growing of cantaloupes, grapefruit, honeydew melons, oranges, and watermelons. Irrigation has turned the once unproductive soil of the Rio Grande area into one of the finest fruit belts in the United States. Other semitropical fruits, including dates and figs, also grow well in the Southwest.

Transportation. The Spaniards built the first road in the Southwest in 1581, between the Santa Fe area and Mexico City. They named it *El Camino Real*, or The Royal Road. This old route parallels present-day U.S. 85. The first railroad did not penetrate the region until 1869, because the mountains and deserts hampered construction. Until that time, travelers came by stagecoaches that lumbered over the rugged terrain. Today, the Southwest has wide, paved highways, an extensive railroad system, and large ports on the Gulf Coast. The Gulf Intracoastal Waterway provides cheap barge service between all Texas ports and the Mississippi Valley (see GULF INTRACOASTAL WATERWAY).

Large southwestern cities have modern airports that serve the major domestic airlines. Private landing fields lie scattered throughout the region. Many ranch owners use planes to oversee their property.

Regional Cooperation. New England, the Middle Atlantic States, and the South had become thriving centers of trade and culture long before the opening of the Southwest. Settlers did not begin to move southwestward in great numbers until the early 1900's. Until this time, lack of good transportation, great distances between settlements, and hostile Indians delayed development. Arizona and New Mexico, which became states in 1912, were the last territories to achieve statehood until Alaska and Hawaii did so in 1959.

The Southwestern States entered a period of rapid growth in the mid-1900's, after mass production of automobiles and the expansion of paved highways. The widespread use of air conditioning and evaporative cooling equipment also helped the region's economy by providing comfort from the extreme heat. Activity increased in mining, agriculture, and manufacturing. The population of the Southwest more than doubled between 1900 and 1930.

The population increased at a much slower rate between 1930 and 1960. The region's chief problem, lack of water, contributed to this slower rate of growth. Water is in short supply because streams in the Southwest are comparatively small, and most areas have slight rainfall. In the continuing search for water, all the Southwestern States dammed rivers and tapped great underground water-storage basins with deep-well pumps. Groups of citizens formed organizations, such as the Aqualantes, to persuade Congress to set aside funds for a systematic program of developing the Colorado, the region's largest river. In 1949, New Mexico joined Utah, Colorado, and Wyoming in establishing the Upper Colorado River Basin Pact to provide more water for irrigation and industrial use. In the 1960's, the population again began to increase rapidly.

Through the years, many herds of livestock have fed on the prairie grasslands, exhausting these grazing areas. Erosion by cloudbursts also wore away the rich topsoil. Today, soil-conservation commissions of Arizona,

SOUTHWESTERN STATES

New Mexico, Oklahoma, and Texas work together to restore and conserve the vast grazing regions in these states. Critically reviewed by NATT N. DODGE

Related Articles. For additional information on the Southwestern States, see the separate article on each of the states in this region with its list of Related Articles. Other related articles in WORLD BOOK include:

HISTORY AND GOVERNMENT

Alamo
City Government
Cliff Dwellers
Guadalupe Hidalgo, Treaty of
Indian, American
Indian Territory
Indian Wars
Local Government
Mexican War
Pioneer Life in America
Pony Express
San Jacinto, Battle of
Santa Fe Trail
State Government
Texas Rangers
Trails of Early Days
United States, Government of
United States, History of
Western Frontier Life
Westward Movement

PHYSICAL FEATURES

Canadian River
Carlsbad Caverns National Park
Colorado River
Dam
Desert
Dust Bowl
Gila River
Grand Canyon National Park
Gulf of Mexico
Mesa
National Park System
Painted Desert
Pecos River
Petrified Forest
Red River
Rio Grande

Outline

I. The Land and Its Resources
- A. Land Regions
- B. Climate

II. Activities of the People
- A. The People
- B. Mining
- C. Manufacturing and Processing
- D. Agriculture
- E. Transportation
- F. Regional Cooperation

Questions

What industry brings the Southwest the largest part of its income?

Why is the Spindletop field in Texas important? Where is it located?

What are the six C's around which most of the Southwest's economic activity centers?

What are three factors that retarded development of the Southwestern States?

How did the United States acquire much of the Southwestern region?

Who was the first white man to enter the Southwestern region?

What famous canyon lies in the Southwest? What other tourist attractions lie in this region?

What are the leading manufactured products of the Southwest?

What Southwestern city is the oldest seat of government in the United States?

What two Southwestern States lead in uranium-ore mining?

What Southwestern ranch is the largest in the United States?

What are the main cultures represented in the Southwestern States?

What two cities in New Mexico are important to national defense? Why?

SOUTHWESTERN UNIVERSITY is a coeducational liberal arts school in Georgetown, Tex. It is controlled by the United Methodist Church. It has a college of arts and sciences and a school of fine arts. In 1840, the Republic of Texas chartered Southwestern. It is the oldest university in Texas. For enrollment, see UNIVERSITIES AND COLLEGES (table).

SOVEREIGN. See POUND STERLING.

SOVEREIGNTY. The name "sovereign" was first applied to kings. Everyone in a kingdom was a subject of the king. The king himself was usually *sovereign*, which means *subject to no one*.

Few kings are left in the world, but the idea of sovereignty remains. Today, many countries are considered subject to no one, and therefore sovereign. A sovereign country can conduct its own affairs, enter into treaties, declare war, or adopt any other course of action without another country's consent. Small countries are often sovereign in name only. They shape their policies and conduct their affairs to suit the desires or needs of a stronger country.

The United States of America is a sovereign nation, but the 50 states which compose it do not have full sovereignty. PAYSON S. WILD

SOVIET, *SOH vih ET*, or *SO vih et*, is a Russian word which means *council*. Russian revolutionary groups were known as soviets. The first soviets were formed during the Russian workers' revolution in 1905. Soviets were formed throughout Russia after the downfall of the Czar in March, 1917. These soviets were councils made up of workers, peasants, and soldiers. These councils rallied groups of people to support the Socialist plan for setting up a Russian government. In 1917, the Bolsheviks (Lenin faction) gained control of the soviets. Since 1924, Russia has been officially known as the Union of Soviet Socialist Republics. Since 1946, the Russian army and navy have been officially known as the Soviet Army and Soviet Navy. WILLIAM B. BALLIS

SOVIET UNION. See RUSSIA.

SOVKHOZY. See RUSSIA (Agriculture).

SOW. See HOG.

SOW BUG. See WOOD LOUSE.

SOW THISTLE, *sou*, is the name of a group of weeds. These weeds grow wild in Europe, and several species have been introduced into the United States, where they have become a nuisance in gardens and fields. The *annual sow thistle* grows 2 to 3 feet (61 to 91 centimeters) high and has a branching stem. It contains a milky juice and its flower heads resemble dandelions. Another type of sow thistle is the *perennial sow thistle*. The sow thistle is one of the most troublesome weeds.

Sow Thistles have yellow flowers and prickly leaves. USDA

Scientific Classification. Sow thistles belong to the composite family, *Compositae*. The annual sow thistle is classified as genus *Sonchus*, species *S. oleraceus*. The perennial sow thistle is *S. arvensis*. LOUIS PYENSON

SOWING MACHINE. See DRILL (seeder).

SOYBEAN. The soybean is a farm crop that supplies animal feed, food for human beings, and many raw materials for industry. The soybean plant is an annual, and belongs to the pea family. Plants in this family are sometimes called *legumes*.

Soybeans have been part of the history of China for about 5,000 years. The ancient Chinese used the soybean as food, and made medicines from it. Soybeans have been grown in the United States for more than 150 years. But, during the early years, the soybean was grown chiefly to be mowed as hay, which was used as livestock feed. When chemists and manufacturers recognized the importance of the bean itself, the great new soybean-processing industry was born. Today, the soybean is the nation's largest single source of vegetable oil, and of protein meal for livestock feeding.

Uses of the Soybean

The Plant is used widely as hay, *silage* (winter food for stock) and *pasturage* (green food for stock). The plant contains certain bacteria that add nutrients to soil. Thus, many farmers rotate the planting of soybeans with other crops on the same field. The soybeans enrich the soil for crops that follow them.

The Bean is rich in food values. It has more protein than beef, more calcium than milk, and more of a fatty substance called *lecithin* than eggs. Lecithin from soybeans is used in candy, breads, and drugs. Soybeans also are rich in vitamins, minerals, and acids.

Most soybeans are processed for oil. About one-fifth of the bean is oil. In the early 1970's, over 80 per cent of the soybean oil produced in the United States was used in edible products. These products included margarine, shortening, and cooking oils. Industry uses soybean oil to make such products as paints and ink.

Soybean meal is made from the beans and bean hulls after the oil is extracted. The meal is an important livestock feed. Soybeans probably supply more than half of all the protein meals fed to livestock in the United States.

Soybeans may be ground into soy flour, which is used to make breads, pancakes, puddings, soups, and many other foods. Soy sauce, a salty brown sauce made from soybeans, is used to flavor foods—especially in Chinese and Japanese cooking. Soybeans can be processed into foods that look and taste like beef, pork, and other kinds of meat. *Vegetarians* (people who do not eat meat) make up the largest market for these imitation meats. Food processors also make a soybean substance that can be added to ground beef to increase the number of servings the meat yields. Meat mixed with this nutritious product costs less than pure meat.

Soybean meal is used in the manufacture of many chemical products, from paints to fire-extinguisher fluid. The important germ-killer *streptomycin* is made by growing a certain organism in broth containing soybean meal. This meal also is used in making paper coatings, adhesives, sizing for cloth, fertilizer, linoleum backing, insect sprays, and dozens of other products. Finding new uses for the soybean has been one of the achievements of the science of *chemurgy*. See CHEMURGY.

Description and Varieties

The soybean is derived from a wild plant of eastern Asia. As it grows, it branches out and produces thick leaves. The plant grows from 2 to 3½ feet (61 to 107 centimeters) or more in height. The stems, leaves, and pods are covered with short, fine, brown or gray hairs. Small white or purple flowers appear where the leaf joins the stem. The bean pods range in color from very light yellow to shades of gray, brown, and black. Each contains from two to four round or oval seeds. The seeds themselves may be colored in shades of yellow, green, brown, black, or may be speckled.

More than a hundred useful varieties of soybeans have been developed in the United States. Many important new varieties have been produced by *hybridization* (crossing varieties of the plant). The characteristics of both plant and bean vary with the soil, methods of cultivation, seasonal conditions, and locality.

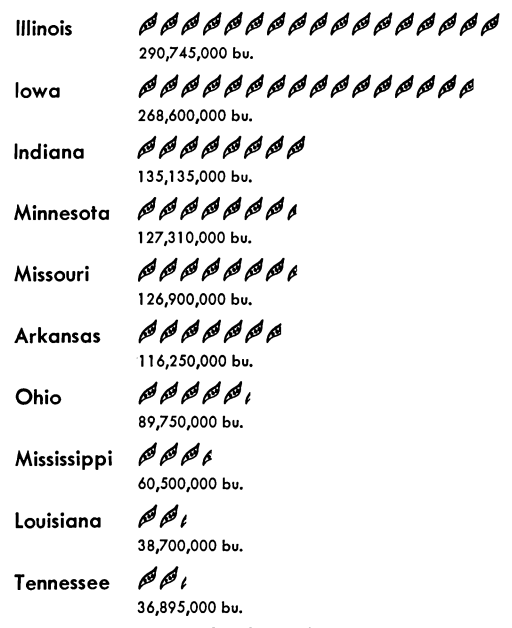
The yellow-seeded varieties have the most oil. When the oil has been pressed out, the meal that is left can be used in food and other products. Most varieties grown for beans are used for stock feed. Some farmers grow small-seeded, fine-stemmed, trailing varieties to be used as hay or as a soil fertilizer.

Culture

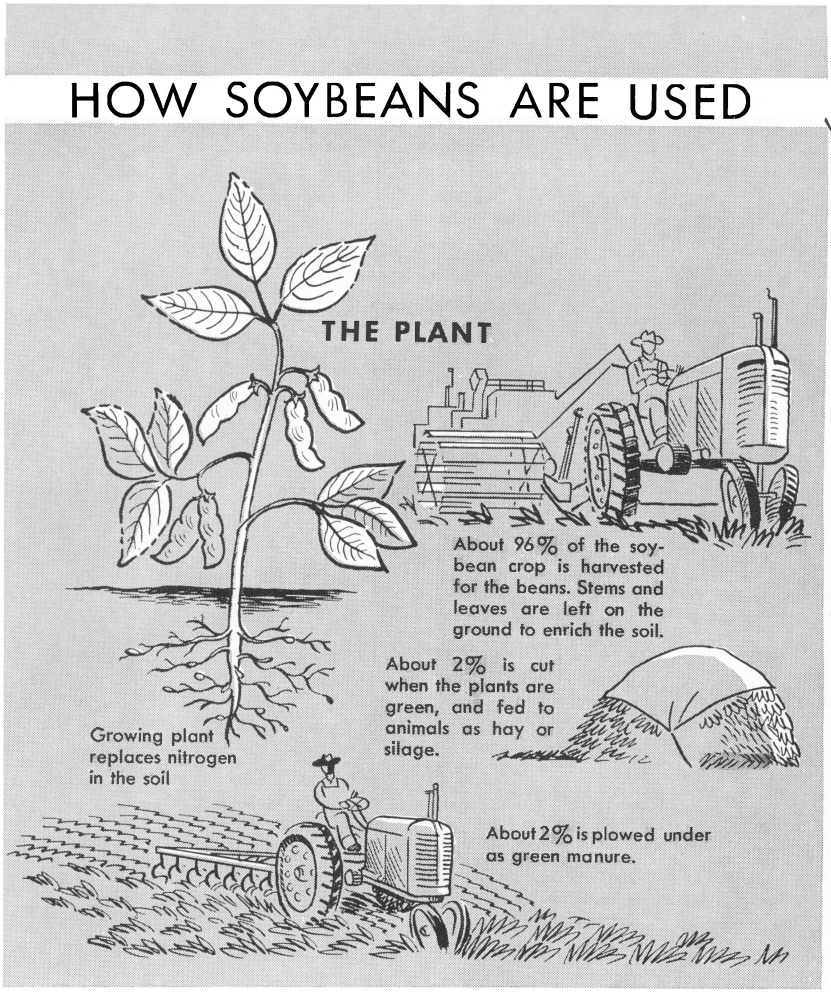
Soybeans grow best in areas where corn grows best. They need almost the same soil, fertility, and climate. A well-drained, warm, fertile loam soil is excellent for soybeans. Reasonably good crops can be grown on drained swamplands and muck soils. Soils of low fertility can be used if they are limed, fertilized, and inoculated. Soybeans should always be grown where the soil contains the nitrogen-fixing organism which can produce nodules on the plant's roots. Without this organism, the crop yield is less and the nitrogen-fixing benefit of the legume will not be realized.

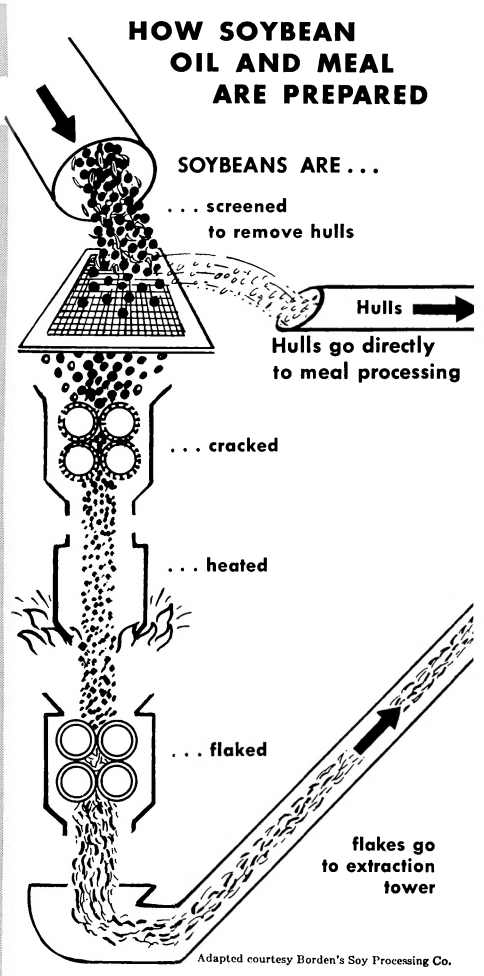
LEADING SOYBEAN-GROWING STATES

Bushels of soybeans grown in 1973*



*One bushel equals 60 pounds (27 kilograms).
Source: *Crop Production 1973 Annual Summary*, U.S. Department of Agriculture.





The soybean is grown in widely spaced rows like corn and closely spaced like small grains. Whichever method is used, weeds should be controlled with a rotary hoe, spike-tooth harrow, or heavy weeder.

The soybean has few enemies in the United States, although in the Orient it is attacked by serious plant diseases. Some fungus, bacterial, and virus diseases exist in the United States. Among the insect enemies are grasshoppers, blister beetles, leafhoppers, the green clover worm, and the velvet-bean caterpillar. However, these insects seldom spoil a crop. Woodchucks and rabbits can cause serious damage.

Development of the Soybean

The soybean is one of the oldest crops grown by man. In 2838 B.C., the Emperor Shung Nung of China wrote a description of the soybean plant. This is said to be the earliest record of the plant. The ancient Chinese considered the soybean their most important crop, and one of the five sacred grains necessary for living. By the 1600's, soybeans had been tried in Germany, England, France, and Hungary. But the crop was not large in any part of Europe until recent years.

It was not until 1804 that the soybean found its way into American records. At that time, James Mease wrote, "The soybean is adapted to Pennsylvania and should be cultivated." In 1854, the Perry expedition to Japan brought back a few varieties. Several more varieties and seeds were brought across the Pacific in 1889 and 1890. The U.S. Department of Agriculture, in cooperation with 22 state agronomy departments, has introduced many varieties for various growing regions and for special uses, and thus has boosted the commercial growth of the soybean. The greatest acreage and total production are found in the Middle West. Successful soybean processing began in the early 1920's.

The United States produces about three-fourths of the world's soybean crop. In the early 1970's, it grew more than 1 billion bushels (27 billion kilograms) a year on about 42 million acres (17 million hectares). The United States exports about 9 per cent of its soybeans to Japan—a greater amount than it exports to any other country.

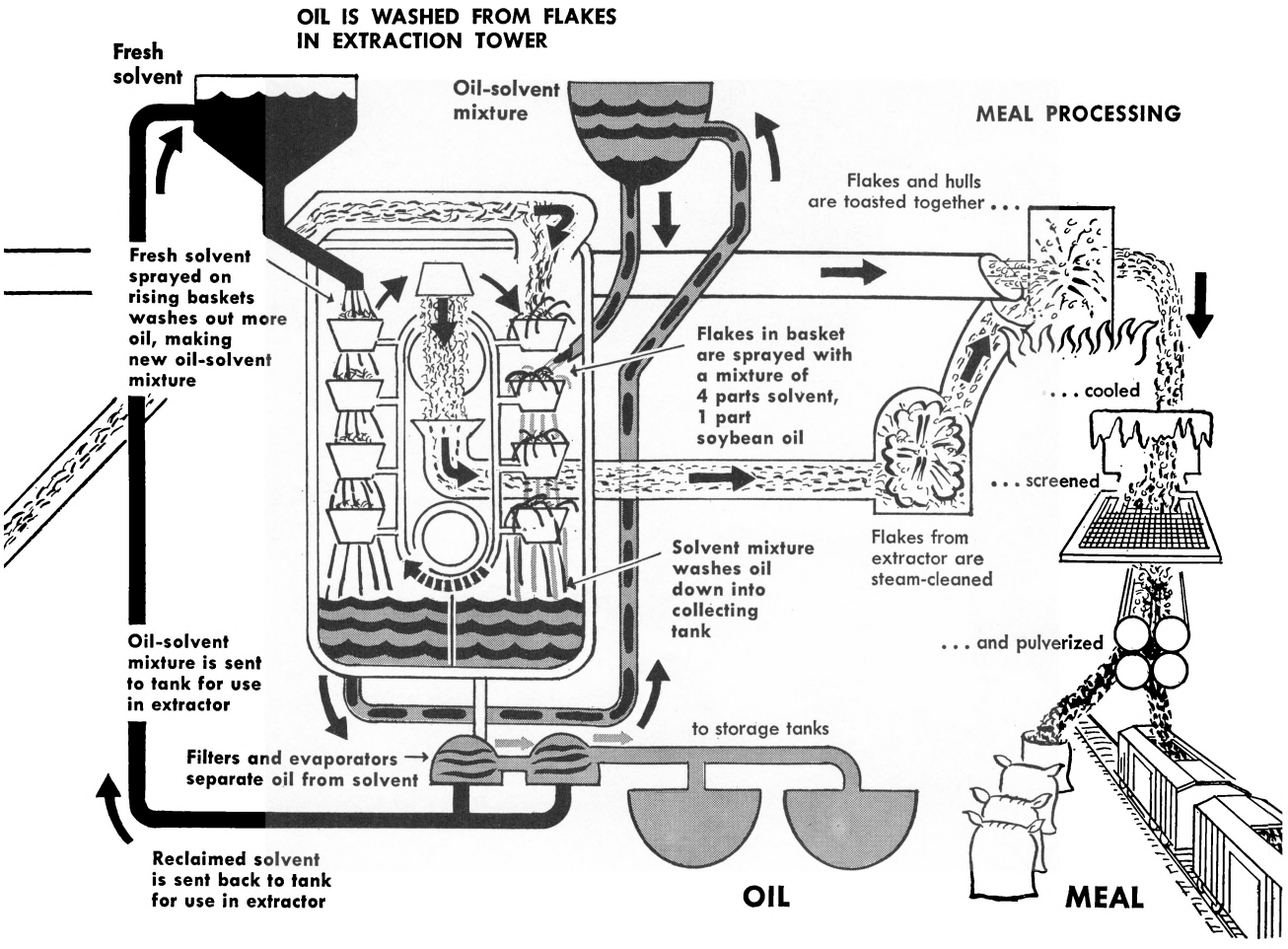
Besides the United States, the countries that are the leading soybean growers include Brazil, China, Indonesia, and Russia. The crop is also grown in Argentina, Cambodia, Canada, Colombia, Japan, Mexico, Nigeria, Paraguay, South Korea, Taiwan, and Thailand.

Scientific Classification. The soybean is in the pea family, *Leguminosae*. It is classified as genus *Glycine*, species *G. max*.

ROBERT G. HOUGHTLIN

Critically reviewed by A. E. STALEY, JR.

SOYUZ. See SPACE TRAVEL (table: Manned Space Flights; Space Stations [with picture]).



SPA. See Baths and Bathing; Mineral Water.

SPAAK, *spahk*, **PAUL-HENRI** (1899-1972), was a European statesman and a leader of the Socialist Party in Belgium. He was elected to Belgium's Chamber of Representatives in 1932. Later, he served in various cabinet posts. He was prime minister in 1938 and 1939 and from 1946 to 1949. He became the first president of the General Assembly of the United Nations in 1946. He helped form the Council of Europe in 1949, and was its first president. Spaak became the Belgian minister of foreign affairs in 1954, and worked to bring about a union of Western European countries. He was a planner of the European Economic Community (Common Market) and Euratom. He was secretary-general of the North Atlantic Treaty Organization (NATO) from 1957 to 1961. Spaak was born in Brussels. Jane K. Miller

SPAATZ, *spahts*, **CARL** (1891-1974), was the first Chief of Staff of the United States Air Force. He won this post because of his record as a distinguished combat leader of the Army Air Forces during World War II.

In 1942, he became commander of the Eighth Air Force in England. He commanded the Northwest African Air Forces in 1943. This combined American-British force supported the conquest of Tunisia and the invasions of Sicily and Italy. Spaatz then led the U.S. Strategic Air Forces in Europe for the final air and ground assault on Germany in 1944 and 1945. See World War II (The Air War in Europe).

After the victory in Europe, Spaatz went to the Pacific, where his air forces included the B-29's that bombed Japan. He commanded the Army Air Forces in 1946, and was Chief of Staff of the newly independent U.S. Air Force in 1947. Born at Boyertown, Pa., Spaatz was graduated from the U.S. Military Academy. Alfred Goldberg

U.S. Signal Corps
Carl Spaatz

SPACE. See Space Travel (What Is Space?).

SPACE COMMUNICATIONS. See Communications Satellite; Space Travel (Artificial Satellites).

SPACE MEDICINE. See Aviation Medicine (Space Medicine).

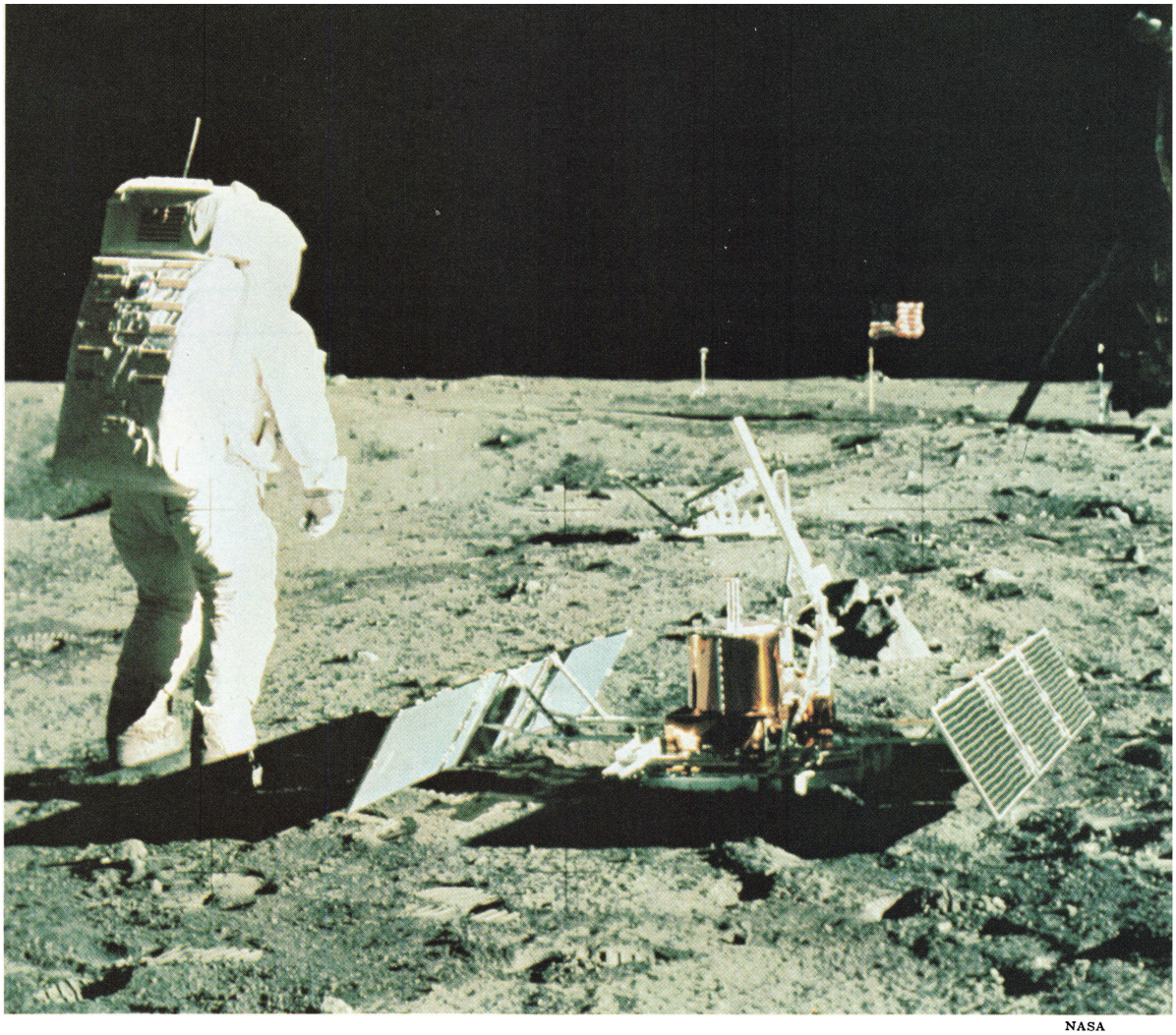
SPACE NEEDLE. See Seattle (The City; picture).

SPACE STATION. See Space Travel.

SPACE SUIT. See Space Travel (picture: Astronaut's Space Suit); Engineering (pictures).

SPACE SURVEILLANCE. See Radar (Radar Warning Systems); DEW Line.

SPACE-TIME. See Fourth Dimension.



NASA

The First Men on the Moon were astronauts Neil A. Armstrong, who took this picture, and Edwin E. Aldrin, Jr., *above*, next to a seismometer. Beyond is a laser reflector. A TV camera and an American flag are in the background. The lunar module *Eagle* stands at the right.

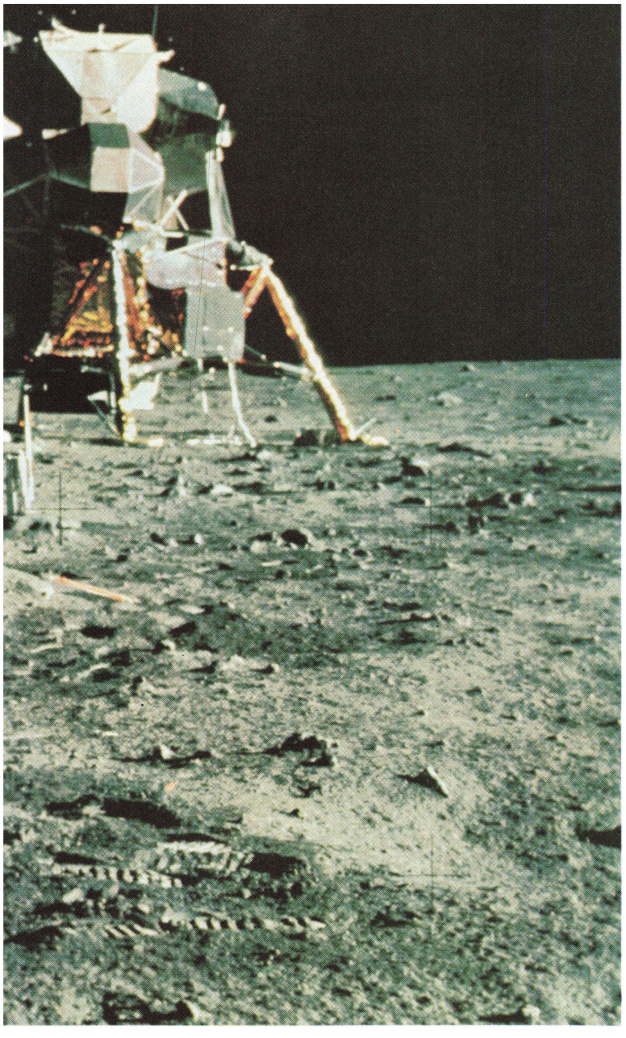
SPACE TRAVEL

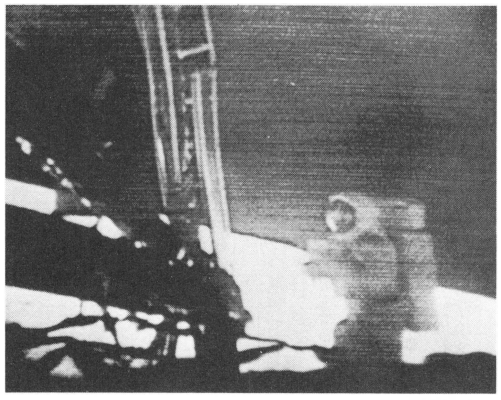
SPACE TRAVEL is man's greatest adventure—the chance to explore the moon, the planets, and the stars. Giant rockets carry explorers into space. A roaring blast of orange flame lifts the rocket from the ground. Climbing into the blue sky, the rocket leaves a white trail. Then it speeds out of sight into space, where the sky is always black and the stars always shine. The rocket may carry men on their way to explore the moon, or it may carry instruments to explore a distant planet.

The space age began on Oct. 4, 1957. On that day, Russia launched *Sputnik I*, the first artificial satellite to circle the earth. The first manned space flight was made on April 12, 1961, when a Russian cosmonaut, Yuri A. Gagarin, orbited the earth in a spaceship. The next month, U.S. astronaut Alan B. Shepard, Jr., made a 15-minute space flight, but he did not go into orbit. On Feb. 20, 1962, John H. Glenn, Jr., became the first American to orbit the earth. He made three revolutions. During the years that followed, many space flights carried men into orbit around the earth. Then, on Dec. 24 and 25, 1968, astronauts Frank Borman, William A. Anders, and James A. Lovell, Jr., orbited the moon 10 times in their Apollo 8 spacecraft.

Man first set foot on the moon on July 20, 1969. Astronaut Neil A. Armstrong stepped out of the Apollo 11 lunar module, named *Eagle*, and climbed backward down a metal ladder. At 10:56 P.M. E.D.S.T., Armstrong put his left foot on a rocky lunar plain called the Sea of Tranquility. After Armstrong had walked around for 18 minutes, astronaut Edwin E. Aldrin, Jr., joined him. For about two hours, the two Americans

Harold L. Goodwin, the contributor of this article, is a deputy program director of the National Oceanic and Atmospheric Administration, and author of The Images of Space *and other books on space travel. The article was critically reviewed by Wernher von Braun, Vice-President for Engineering and Development of Fairchild Industries and former deputy associate administrator of the National Aeronautics and Space Administration.*

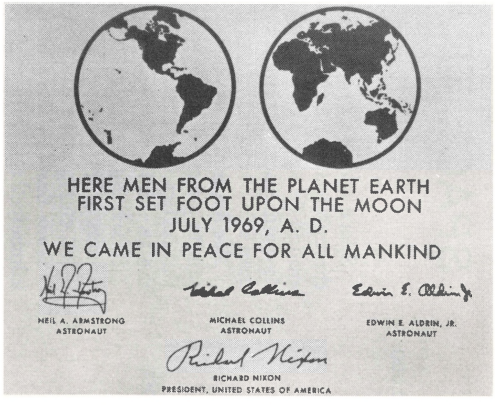




Wide World

Man's First Step on the Moon. As astronaut Neil A. Armstrong, *above*, took the historic step on July 20, 1969, he said: "That's one small step for a man, one giant leap for mankind." The event was televised to the earth, and seen by millions. A plaque, *below*, was attached to the landing craft's descent stage, which was left on the moon.

NASA

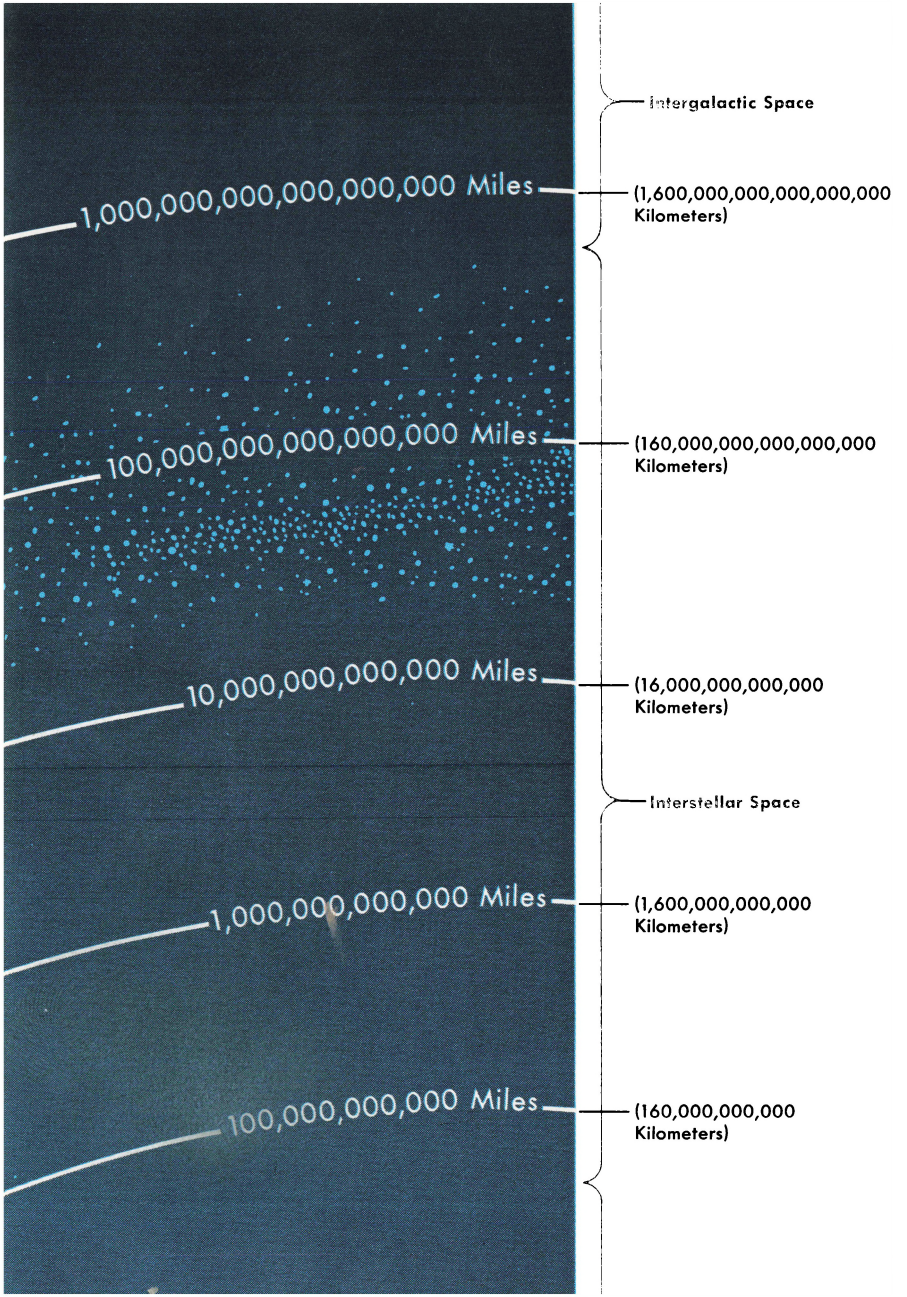


explored near the lunar module and set up several scientific experiments. *Eagle* was on the moon almost 22 hours before Armstrong and Aldrin lifted off to rejoin the command module *Columbia*, piloted by astronaut Michael Collins.

During the years since the space age began, man has found many uses for space travel. The space age developed a huge industry called the aerospace industry to design and build space equipment. A new field of medicine called space medicine came into being to study the problems of living and working in space. Weathermen receive warning of storms with pictures taken by weather satellites. Telephone calls and television pictures are sent around the world by communications satellites. Navigators can map the positions of ships using signals broadcast from navigation satellites. Scientific satellites and space probes discovered the Van Allen radiation belt around the earth and made many other discoveries.

During the early years of the space age, success in space became a measure of a country's leadership in science, engineering, and national defense. As a result, the United States and Russia competed with one another in developing their space programs. Each of them, for example, sought to build better rockets and spacecraft than the other in order to reach the moon first. But both nations gradually began to realize that they could benefit from working together on such scientific projects. In 1975, the United States and Russia cooperated in their first joint space mission. An Apollo spacecraft piloted by three United States astronauts docked with a Soyuz craft manned by two Russian cosmonauts.

Man has always wanted to explore the unknown. Many persons believe that man *should* go to the moon and beyond simply because he *can* go. Scientists hope that space travel will answer many questions about the universe—how the sun, the planets, and the stars were formed, and whether life exists elsewhere in space.



SPACE TRAVEL

WHAT IS SPACE?

Space continues in all directions, and has no known limits. The moon moves through space around the earth. The earth and the other planets circle in space around the sun. The sun and billions of other stars make up a giant *galaxy* whirling through space. Countless other galaxies are scattered throughout space as far as man can see with the largest telescopes.

The Beginning of Space. Space begins where the earth's *atmosphere* (air) is too thin to affect objects moving through it. Near the earth's surface, air is plentiful. But higher above the earth, the air becomes thinner and thinner. Little by little, the atmosphere fades to almost nothing, and space begins.

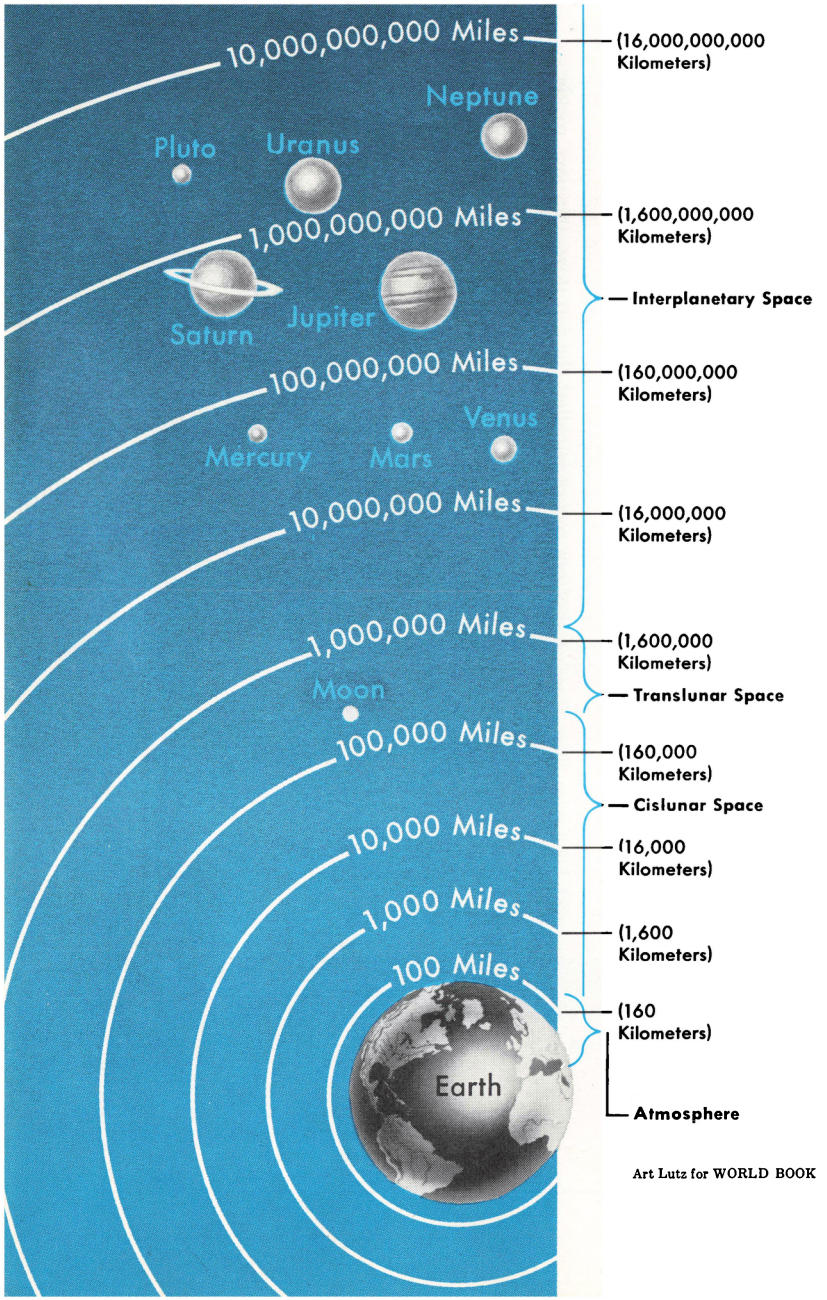
Space usually is said to begin about 100 miles (160 kilometers) above the earth. At this height, a satellite may continue circling the earth for months. But, even there, enough air is still present to slow a satellite and finally cause it to fall.

From Earth to the Moon. The atmosphere continues beyond 100 miles (160 kilometers) above the earth. But it is not like the air near earth. It consists of widely scattered atoms and molecules of gas, and radiation. The radiation consists mostly of electrons, protons, and other subatomic particles. The particles carry electric charges. They are "trapped" in space by the earth's magnetic field. Scientists call the part of the atmosphere that contains these particles the *magnetosphere*.

Space between the earth and moon is called *cislunar* space (*cis* means *on this side*, and *lunar* means *of the moon*). As the moon is approached through cislunar space, earth's gravity becomes weaker and the moon's gravity becomes stronger. The combined gravities of earth and moon are effective to about 1,000,000 miles (1,600,000 kilometers) from earth. This distance is sometimes called *translunar space*.

Space Between the Planets is called *interplanetary space*. The sun's gravity controls interplanetary space. But each planet and moon also has its own gravity. Vast distances separate the bodies that move in interplanetary space. The sun is about 93 million miles (150 million kilometers) from earth. Venus, the closest planet to the earth, approaches only to within about 25 million miles (40 million kilometers) of earth. Mars, the planet most likely to be explored first, comes as close as about 35 million miles (56 million kilometers) to the earth. A trip to Mars and back could take about 17 months. Interplanetary space reaches far beyond Pluto, the most distant planet. It ends where the sun's gravity is no longer effective —perhaps 50 billion miles (80 billion kilometers) from earth.

To the Stars and Beyond. We find even greater distances in *interstellar space* (space between the stars). *Proxima Centauri*, the nearest star, is over 25 trillion miles (40 trillion kilometers) away. To cover such great distances, man would have to travel almost as fast as light. Even then, a round trip to a star could take a whole lifetime. Interstellar space reaches distances impossible to imagine. Then *intergalactic space* (space between the galaxies) begins and never ends.



Art Lutz for WORLD BOOK

SPACE TRAVEL TERMS

Ablation is the melting away of a heat shield during re-entry.

Aerospace includes the atmosphere and the regions of space beyond it.

Aphelion is the point farthest from the sun in the path of a solar satellite.

Apocynthion is the point farthest from the moon in the orbit of a lunar satellite.

Apogee is the point farthest from earth in the orbit of an earth satellite.

Artificial Satellite is a spacecraft that circles the earth or other celestial body. The term is usually shortened to *satellite*, but it then also applies to natural moons.

Astro is a prefix meaning *star*. It also means *space* in such words as *astronautics* (the science of space flight).

Astronaut is a United States space pilot.

Attitude is the position of a spacecraft in relation to its direction of flight.

Biosatellite is an artificial satellite that carries animals or plants.

Booster is a launch vehicle's first stage.

Burnout is the point in the flight of a rocket when its propellant is used up.

Capsule is a manned spacecraft or a small package of instruments carried by a larger spacecraft.

Cosmonaut is a Russian space pilot.

Eccentricity is the variation of a satellite's path from a perfect circle.

Escape Velocity is the speed a spacecraft must reach to coast away from the pull of gravity.

Exhaust Velocity is the speed at which the burning gases leave a rocket.

Gantry is a special crane or movable tower used to service launch vehicles.

Heat Shield is a covering on a spacecraft to protect the craft and astronaut from high temperatures of re-entry.

Hypergol is a rocket fuel that ignites upon contact with an oxidizer.

LOX or **Liquid Oxygen** is a common oxidizer. It is made by cooling oxygen to −183° C (−297° F.).

Module is a single section of a spacecraft that can be disconnected and separated from other sections.

Orbit is the path of a satellite.

Oxidizer is a substance that mixes with the fuel in a rocket, furnishing oxygen that permits the fuel to burn.

Pericynthion is the point closest to the moon in the orbit of a lunar satellite.

Perigee is the point closest to earth in the orbit of an earth satellite.

Perihelion is the point closest to the sun in the path of a solar satellite.

Period is the time it takes for a satellite to make one revolution.

Propellant is a substance burned in a rocket to produce thrust. Propellants include fuels and oxidizers.

Re-entry is that part of a flight when a returning spacecraft begins to descend through the atmosphere.

Rendezvous is a space maneuver in which two or more spacecraft meet.

Retrorocket is a rocket that fires in the direction a spacecraft is moving to slow it down or land it.

Spacecraft is a man-made object that travels through space.

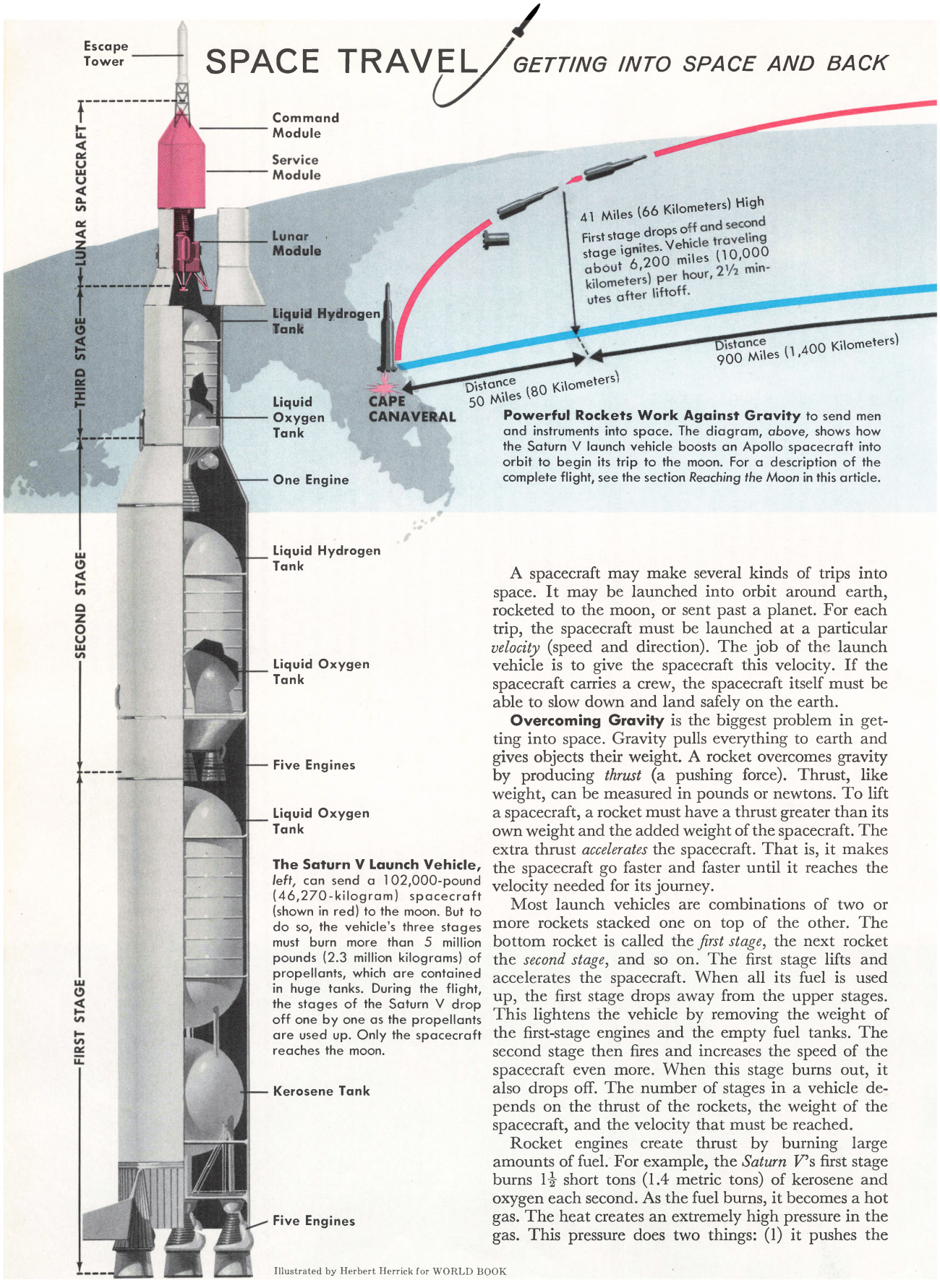
Stage is one of two or more rockets combined to form a launch vehicle.

Thrust is the push given to a rocket by its engines.

Vast Distances in Space separate the earth from the moon, the planets, and the stars. In the illustration, *left*, these bodies appear much closer to the earth than they actually are, because the scale of the drawing changes toward the top. If the diagram had been drawn with 1 inch equal to 1,000 miles (or 1 centimeter equal to 630 kilometers), the picture of the planet Pluto would have to be placed 40 miles (64 kilometers) from the drawing of the earth.

SPACE TRAVEL

GETTING INTO SPACE AND BACK



Powerful Rockets Work Against Gravity to send men and instruments into space. The diagram, *above*, shows how the Saturn V launch vehicle boosts an Apollo spacecraft into orbit to begin its trip to the moon. For a description of the complete flight, see the section *Reaching the Moon* in this article.

The Saturn V Launch Vehicle, *left,* can send a 102,000-pound (46,270-kilogram) spacecraft (shown in red) to the moon. But to do so, the vehicle's three stages must burn more than 5 million pounds (2.3 million kilograms) of propellants, which are contained in huge tanks. During the flight, the stages of the Saturn V drop off one by one as the propellants are used up. Only the spacecraft reaches the moon.

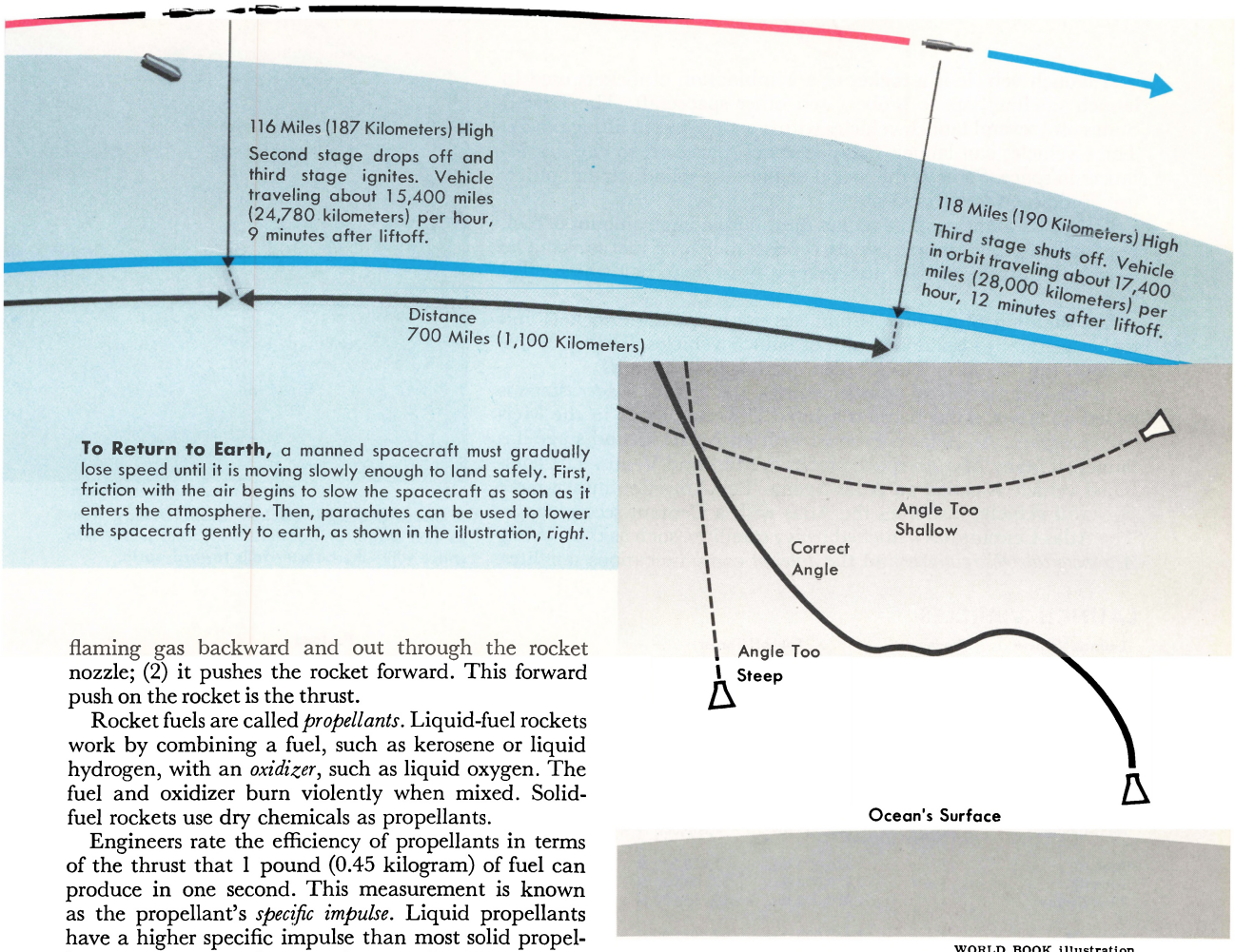
A spacecraft may make several kinds of trips into space. It may be launched into orbit around earth, rocketed to the moon, or sent past a planet. For each trip, the spacecraft must be launched at a particular *velocity* (speed and direction). The job of the launch vehicle is to give the spacecraft this velocity. If the spacecraft carries a crew, the spacecraft itself must be able to slow down and land safely on the earth.

Overcoming Gravity is the biggest problem in getting into space. Gravity pulls everything to earth and gives objects their weight. A rocket overcomes gravity by producing *thrust* (a pushing force). Thrust, like weight, can be measured in pounds or newtons. To lift a spacecraft, a rocket must have a thrust greater than its own weight and the added weight of the spacecraft. The extra thrust *accelerates* the spacecraft. That is, it makes the spacecraft go faster and faster until it reaches the velocity needed for its journey.

Most launch vehicles are combinations of two or more rockets stacked one on top of the other. The bottom rocket is called the *first stage*, the next rocket the *second stage*, and so on. The first stage lifts and accelerates the spacecraft. When all its fuel is used up, the first stage drops away from the upper stages. This lightens the vehicle by removing the weight of the first-stage engines and the empty fuel tanks. The second stage then fires and increases the speed of the spacecraft even more. When this stage burns out, it also drops off. The number of stages in a vehicle depends on the thrust of the rockets, the weight of the spacecraft, and the velocity that must be reached.

Rocket engines create thrust by burning large amounts of fuel. For example, the *Saturn V*'s first stage burns 1½ short tons (1.4 metric tons) of kerosene and oxygen each second. As the fuel burns, it becomes a hot gas. The heat creates an extremely high pressure in the gas. This pressure does two things: (1) it pushes the

Illustrated by Herbert Herrick for WORLD BOOK

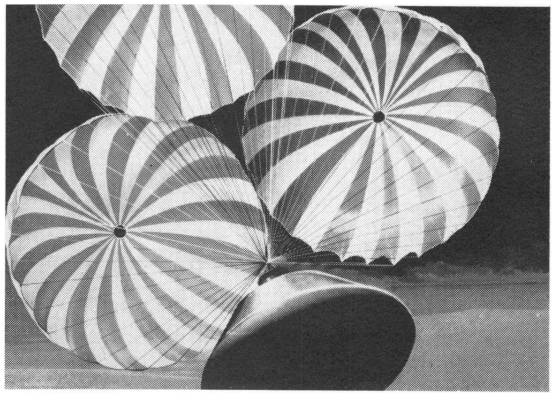


To Return to Earth, a manned spacecraft must gradually lose speed until it is moving slowly enough to land safely. First, friction with the air begins to slow the spacecraft as soon as it enters the atmosphere. Then, parachutes can be used to lower the spacecraft gently to earth, as shown in the illustration, *right*.

WORLD BOOK illustration

An Apollo Spacecraft Returning from the Moon must enter the earth's atmosphere at a certain angle to make a safe landing, *above*. If the angle is too shallow, the spacecraft will not reach earth, but will go back into space. If the angle is too steep, the craft will burn up. Once it is sufficiently slowed down, giant parachutes, *below*, are used to lower the craft to a soft landing.

NASA



flaming gas backward and out through the rocket nozzle; (2) it pushes the rocket forward. This forward push on the rocket is the thrust.

Rocket fuels are called *propellants*. Liquid-fuel rockets work by combining a fuel, such as kerosene or liquid hydrogen, with an *oxidizer*, such as liquid oxygen. The fuel and oxidizer burn violently when mixed. Solid-fuel rockets use dry chemicals as propellants.

Engineers rate the efficiency of propellants in terms of the thrust that 1 pound (0.45 kilogram) of fuel can produce in one second. This measurement is known as the propellant's *specific impulse*. Liquid propellants have a higher specific impulse than most solid propellants. But some, including LOX and liquid hydrogen, are difficult and dangerous to handle. They must be loaded into the rocket just before launching. Solid propellants are loaded into the rocket at the factory, and are ready for use at all times. Large solid-propellant rockets are extremely heavy when loaded with fuel. Because of this, they are difficult to move from the factory to the rocket launch site.

Returning to Earth involves problems opposite to those of getting into space. The spacecraft must lose speed instead of gaining it. For example, a spacecraft returning from the moon may be traveling at a speed of up to 25,000 miles (40,200 kilometers) per hour as it enters the atmosphere. The spacecraft loses most of this speed as it falls through the air. As friction with the air slows the spacecraft, it also produces intense heat. The craft must be able to withstand this heat without burning up. A special plastic *heat shield* protects the craft by melting and vaporizing slowly to carry away excess heat.

At about 40,000 feet (12,000 meters), a special parachute called a *drogue* is released. This chute slows down the spacecraft and straightens it if it is wobbling. At about 10,000 feet (3,000 meters), one or more large parachutes open and lower the craft to earth.

SPACE TRAVEL / LAUNCH VEHICLES

A launch vehicle is a rocket or a combination of rockets used to launch satellites, space probes, and other spacecraft. The United States uses several launch vehicles with a wide range of lifting power. These vehicles can launch many kinds of spacecraft to various distances in space. Some of the rocket engines use solid fuels and others use liquid fuels (see ROCKET).

To launch a spacecraft, a rocket must burn a large amount of fuel. For this reason, a launch vehicle consists mostly of fuel tanks. The more powerful the vehicle, the larger it must be to hold the needed fuel.

The Building Block Idea. Engineers use a few basic rockets and rocket engines to build a family of launch vehicles. They call this method the "building block" idea. Here is how it works.

In the Atlas family of launch vehicles, the first, or *booster*, stage is called an Atlas. Atlas boosters orbited U.S. astronauts in the Mercury program. An Atlas combined with an Agena second stage has launched many *Mariner* space probes to Mars and Venus. The combined vehicle is called an Atlas-Agena. The Atlas-Centaur, a more powerful vehicle, combines the Atlas with a Centaur second stage. The Atlas-Centaur has launched heavy satellites, such as the *Orbiting Astronomical Observatories* and the *Intelsat* communications satellites.

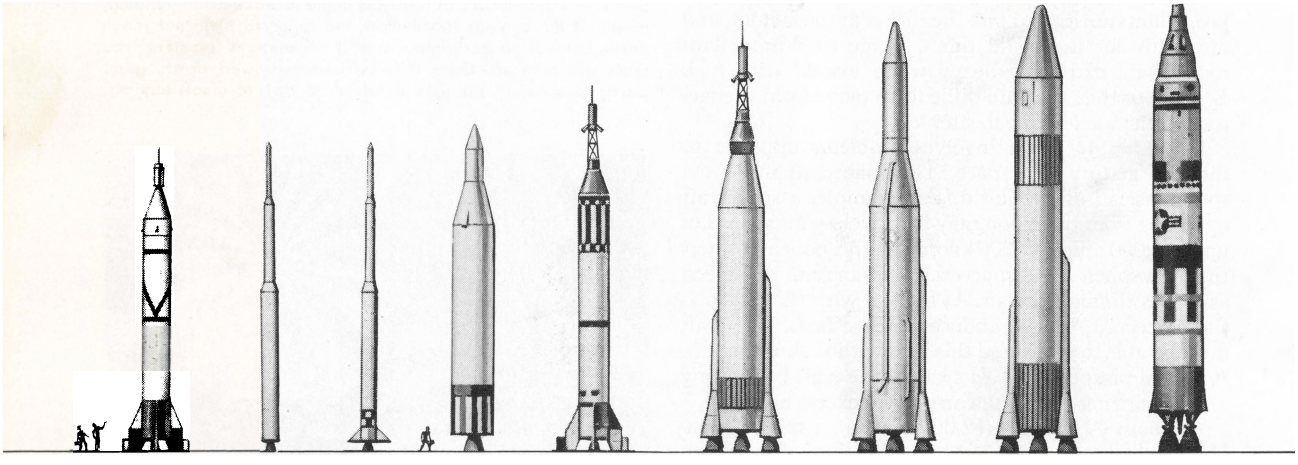
Courtesy Pratt & Whitney Aircraft

A Second-Stage Rocket Blasts Away from its first stage, or booster. The rocket heads into space while the booster falls toward earth.

LAUNCH VEHICLES

Launch Vehicle	Stages	Takeoff Thrust		Payload
*Vanguard	3	28,000 lbs.	125,000 N†	50 lbs. (23 kg) in earth orbit
*Jupiter C	4	82,000 lbs.	365,000 N	30 lbs. (14 kg) in earth orbit
Scout	4	107,200 lbs.	476,850 N	410 lbs. (186 kg) in earth orbit; 85 lbs. (39 kg) to moon
*Juno II	4	150,000 lbs.	667,000 N	100 lbs. (45 kg) in earth orbit
*Mercury-Redstone	1	82,000 lbs.	365,000 N	3,000 lbs. (1,400 kg) suborbital
Delta	3	205,000 lbs.	911,900 N	3,900 lbs. (1,770 kg) in earth orbit; 1,050 lbs. (476 kg) to moon
*Mercury-Atlas	1½**	367,000 lbs.	1,632,000 N	3,000 lbs. (1,400 kg) in earth orbit
Atlas-Agena	2½**	400,000 lbs.	1,800,000 N	7,700 lbs. (3,490 kg) in earth orbit; 1,430 lbs. (649 kg) to moon; 1,000 lbs. (450 kg) to Mars or Venus
Atlas-Centaur	2½**	400,000 lbs.	1,800,000 N	10,300 lbs. (4,672 kg) in earth orbit; 2,500 lbs. (1,130 kg) to moon; 2,200 lbs. (998 kg) to Mars or Venus
*Titan II	2	430,000 lbs.	1,910,000 N	8,600 lbs. (3,900 kg) in earth orbit
Titan IIIC	3 or 4	2,400,000 lbs.	10,700,000 N	26,000 lbs. (11,800 kg) in earth orbit; 6,200 lbs. (2,810 kg) to moon
Titan-Centaur	4	2,400,000 lbs.	10,700,000 N	35,000 lbs. (15,900 kg) in earth orbit; 11,500 lbs. (5,216 kg) interplanetary missions
Saturn IB	2	1,640,000 lbs.	7,295,000 N	34,000 lbs. (15,400 kg) in earth orbit
Saturn V	3	7,570,000 lbs.	33,670,000 N	285,000 lbs. (129,300 kg) in earth orbit; 107,000 lbs. (48,530 kg) to moon; 70,000 lbs. (32,000 kg) to Mars or Venus

*No longer in use. **Half stage is droppable booster engine.
†*N* is the abbreviation for *newton*, the unit of force in the metric system.



Jupiter C	Vanguard	Scout	Juno II	Mercury-Redstone	Mercury-Atlas	Atlas-Agena	Atlas-Centaur	Titan II
68⅓ ft. (20.8 m)	72 ft. (21.9 m)	72 ft. (21.9 m)	76 ft. (23.2 m)	83 ft. (25.3 m)	95⅓ ft. (29.1 m)	102 ft. (31.1 m)	109 ft. (33.2 m)	109 ft. (33.2 m)

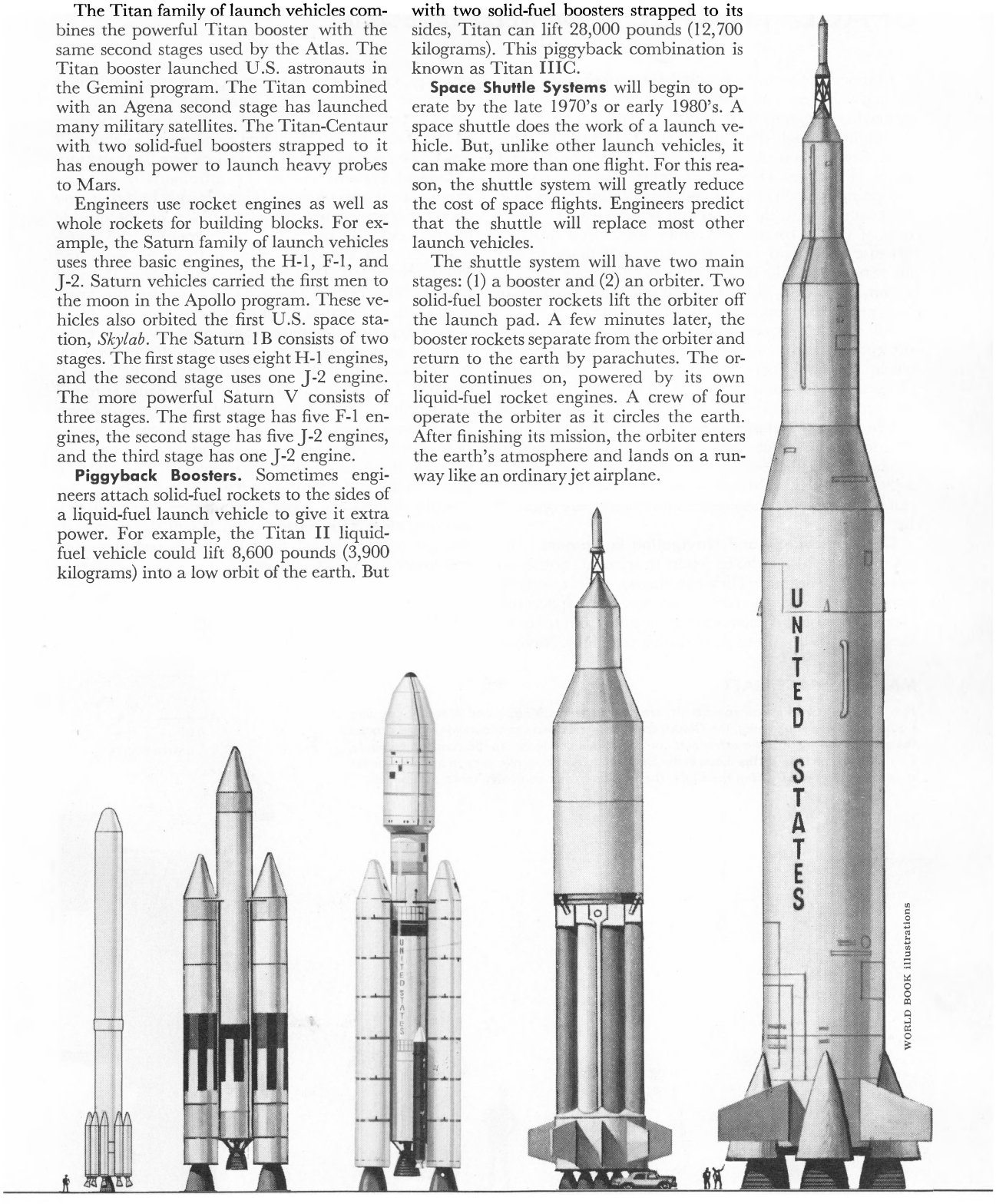
The Titan family of launch vehicles combines the powerful Titan booster with the same second stages used by the Atlas. The Titan booster launched U.S. astronauts in the Gemini program. The Titan combined with an Agena second stage has launched many military satellites. The Titan-Centaur with two solid-fuel boosters strapped to it has enough power to launch heavy probes to Mars.

Engineers use rocket engines as well as whole rockets for building blocks. For example, the Saturn family of launch vehicles uses three basic engines, the H-1, F-1, and J-2. Saturn vehicles carried the first men to the moon in the Apollo program. These vehicles also orbited the first U.S. space station, *Skylab*. The Saturn 1B consists of two stages. The first stage uses eight H-1 engines, and the second stage uses one J-2 engine. The more powerful Saturn V consists of three stages. The first stage has five F-1 engines, the second stage has five J-2 engines, and the third stage has one J-2 engine.

Piggyback Boosters. Sometimes engineers attach solid-fuel rockets to the sides of a liquid-fuel launch vehicle to give it extra power. For example, the Titan II liquid-fuel vehicle could lift 8,600 pounds (3,900 kilograms) into a low orbit of the earth. But with two solid-fuel boosters strapped to its sides, Titan can lift 28,000 pounds (12,700 kilograms). This piggyback combination is known as Titan IIIC.

Space Shuttle Systems will begin to operate by the late 1970's or early 1980's. A space shuttle does the work of a launch vehicle. But, unlike other launch vehicles, it can make more than one flight. For this reason, the shuttle system will greatly reduce the cost of space flights. Engineers predict that the shuttle will replace most other launch vehicles.

The shuttle system will have two main stages: (1) a booster and (2) an orbiter. Two solid-fuel booster rockets lift the orbiter off the launch pad. A few minutes later, the booster rockets separate from the orbiter and return to the earth by parachutes. The orbiter continues on, powered by its own liquid-fuel rocket engines. A crew of four operate the orbiter as it circles the earth. After finishing its mission, the orbiter enters the earth's atmosphere and lands on a runway like an ordinary jet airplane.



Delta 116 feet (35.4 m) | **Titan IIIC** 135 ft. (41.1 m) | **Titan-Centaur** 160 ft. (48.8 m) | **Saturn IB** 224 ft. (68.3 m) | **Saturn V** 363 ft. (110.6 m)

Manned spacecraft are lifted into space atop huge launch vehicles. The spacecraft's upper end is usually somewhat streamlined to reduce air resistance during the flight through the atmosphere. For example, *Mercury*, *Gemini*, and *Apollo* spacecraft have the general shape of a cone. They are launched with the narrow end pointing up. They descend through the atmosphere backwards—with the broad end pointing in the direction of flight. In this way, they lose speed quickly, because the broad end offers great resistance to the air. Spacecraft like the Apollo *lunar module* are not streamlined at all. This spacecraft is designed to operate only near the moon, where there is no air.

All manned spacecraft carry special equipment to protect the astronauts and bring them safely back to earth. This equipment includes (1) life-support systems, (2) communications and navigation equipment, (3) control systems, and (4) re-entry and landing equipment.

Life-Support Systems supply the astronauts with oxygen, food, and water. Oxygen and water are carried in tanks. Food is freeze-dried and stored in meal-size packages. Solid body wastes are sealed into plastic bags and stored aboard the spacecraft. Liquid wastes are released into space.

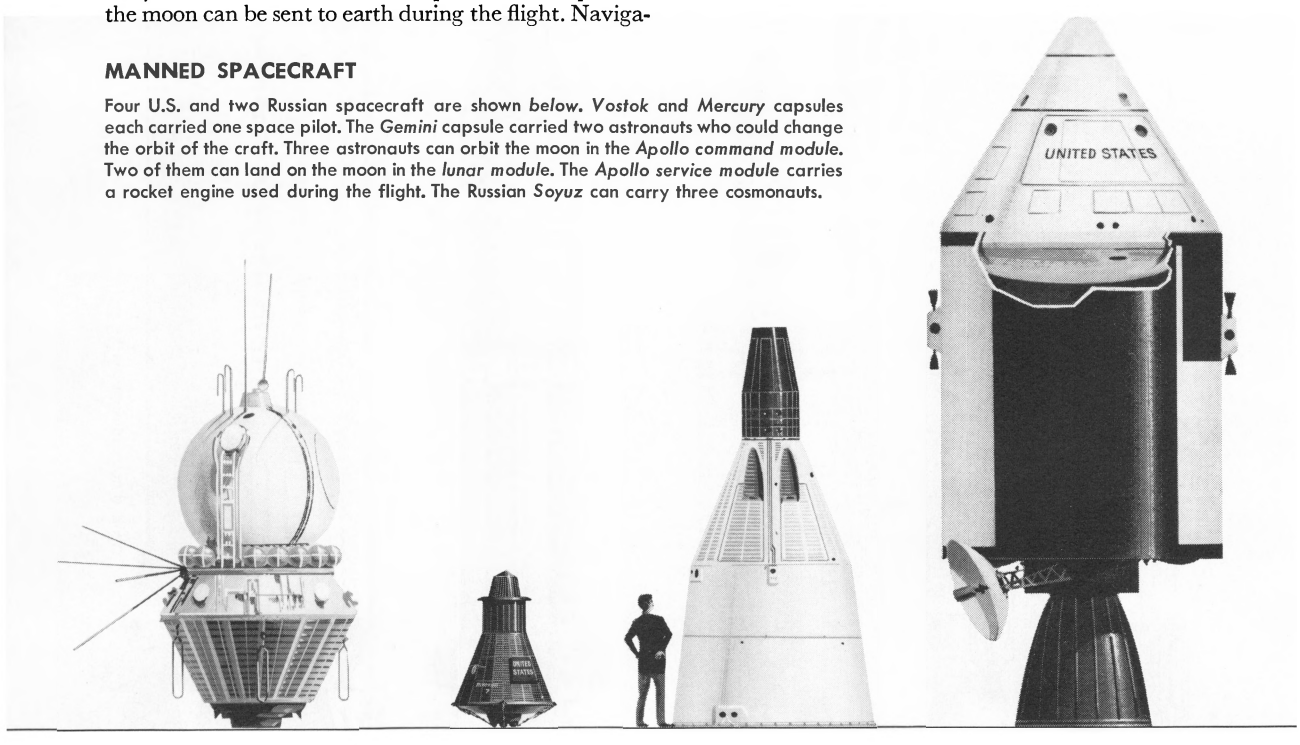
Communications and Navigation Equipment. The astronauts need a radio to report to scientists and engineers on the ground. They can answer their questions and ask for directions in an emergency. Some spacecraft carry a television camera so that pictures from space or the moon can be sent to earth during the flight. Navigation equipment includes sextants, gyroscopes, and small electronic computers. The astronauts use this equipment to find their position in space and to check their course. *Telemetry* equipment sends information about all spacecraft systems to ground stations (see TELEMETRY).

Control Systems enable the astronauts to put the spacecraft in any position. They do this by firing tiny rocket motors located at various places on the outside of the craft. By operating these motors, the astronauts can tilt the craft, point it to either side, and roll it right or left. To re-enter the atmosphere, the craft must point a certain way, or else it might skip away from earth or descend too fast and burn up.

Re-Entry and Landing Equipment includes retrorockets, heat shield, and parachutes. *Retrorockets* are small rockets that fire in the direction the craft is moving. They slow the craft down and cause it to fall out of orbit. The *heat shield* protects the astronauts from the intense heat generated when the craft plunges through the atmosphere. It is a thick layer of material covering the broad end of the spacecraft. The material partly melts and partly vaporizes during re-entry. Air flowing around the spacecraft removes this material, carrying away most of the heat. When the spacecraft has lost enough speed and altitude, parachutes open and lower it gently to the earth.

MANNED SPACECRAFT

Four U.S. and two Russian spacecraft are shown *below*. *Vostok* and *Mercury* capsules each carried one space pilot. The *Gemini* capsule carried two astronauts who could change the orbit of the craft. Three astronauts can orbit the moon in the *Apollo command module*. Two of them can land on the moon in the *lunar module*. The *Apollo service module* carries a rocket engine used during the flight. The Russian *Soyuz* can carry three cosmonauts.

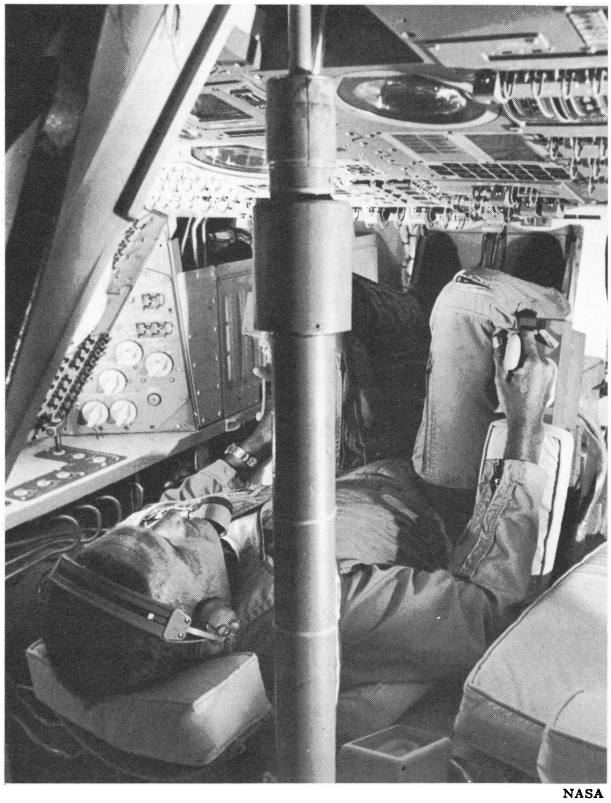


Russian Vostok
About 16 ft.
(4.9 m)

Mercury capsule
6⅞ ft.
(2.1 m)

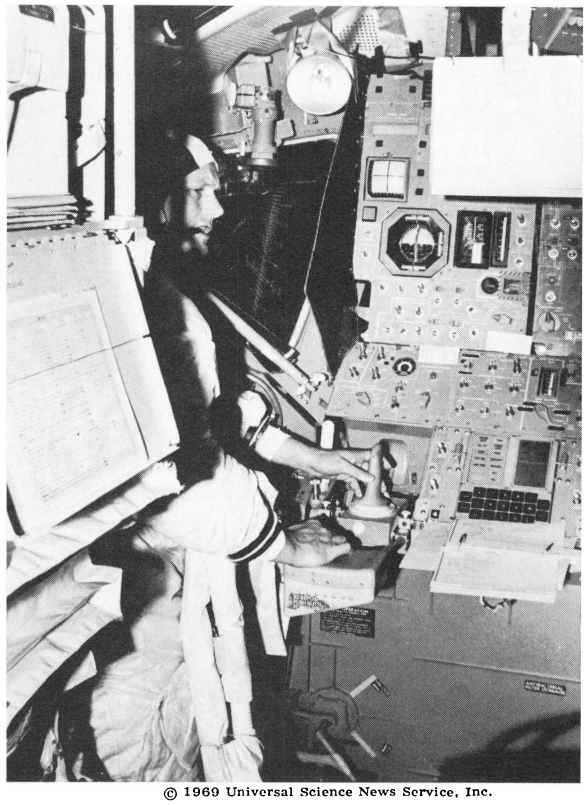
Gemini capsule
19 ft.
(5.8 m)

Apollo command and service modules
35⅓ ft.
(10.8 m)



NASA

Inside an Apollo Command Module, the pilot moves a control stick to turn the spacecraft. Astronaut Frank Borman is shown lying on his couch during a ground test.



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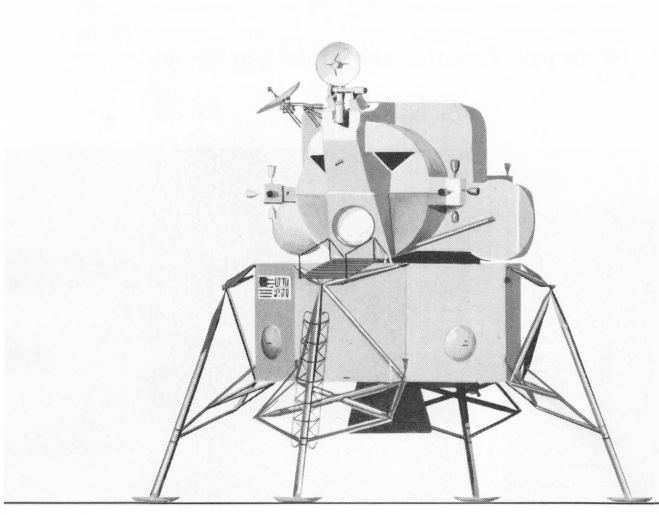
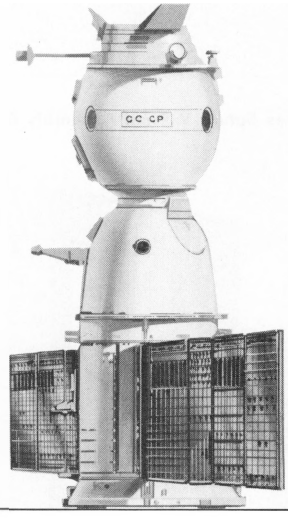
Inside an Apollo Lunar Module Simulator, astronaut Neil A. Armstrong practices a moon landing. Through a window to his left, he sees a simulated moonscape.



Apollo lunar module
22⅞ ft.
(7 m)

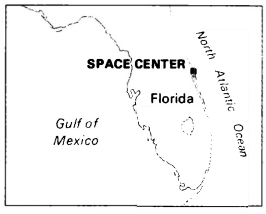


Russian Soyuz
23⅜ ft.
(7.1 m)

SPACE TRAVEL / LAUNCH OPERATIONS

John F. Kennedy Space Center

Kennedy Space Center lies on the Atlantic coast of Florida. The Saturn V space vehicles that carried the astronauts to the moon were launched from pads 39A and 39B.



WORLD BOOK map

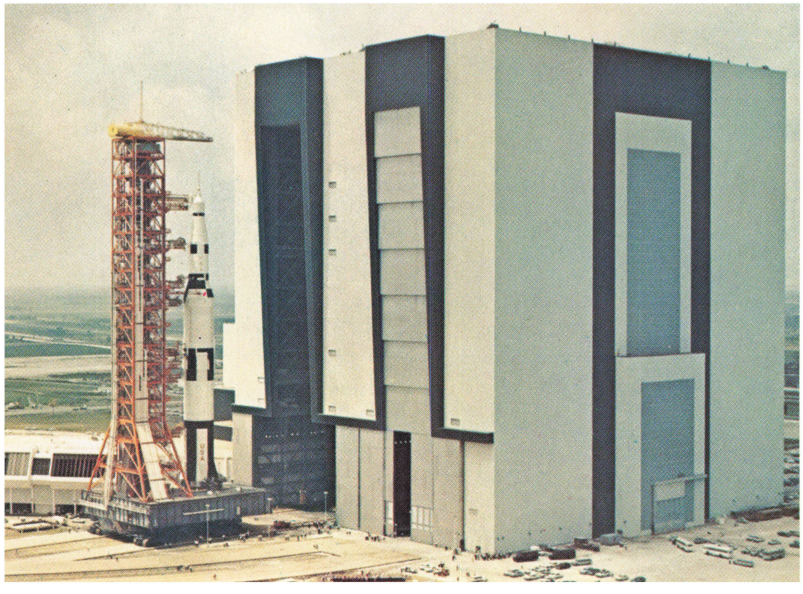
The equipment needed to launch a space vehicle depends on the vehicle's size. A small sounding rocket, for example, can be launched from a simple stand that has a rail for guiding the rocket. But a huge vehicle such as the Saturn V needs a special *launch complex*.

The Saturn V is a three-stage launch vehicle used in the Apollo program. The rocket launches the Apollo spacecraft and its crew of three astronauts into orbit around the earth. Once in orbit, the third stage fires again to send the spacecraft to the moon. After the Apollo program, Saturn V launch vehicles may lift space stations or large telescopes into orbit around the earth. The pictures on these pages show the equipment used to launch the Saturn V at the John F. Kennedy Space Center at Cape Canaveral, Fla.

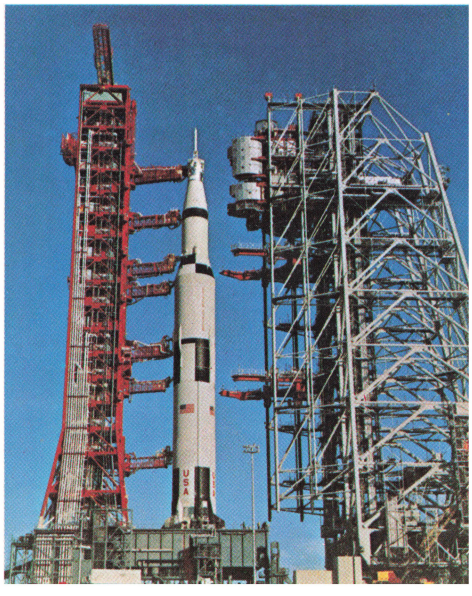
The three stages of the Saturn V and the Apollo spacecraft are connected together inside the 52-story Vehicle Assembly Building. Then a giant tractorlike machine called a *crawler* carries the rocket and its *mobile launching tower* to one of two launch pads. The crawler sets the tower and rocket on the pad and then moves a *service tower* next to the rocket. From the service tower, technicians put kerosene fuel (called RP-1) and liquid oxygen (called LOX) into the first stage. They then fill the second and third stages with liquid hydrogen and LOX. The tanks in the spacecraft are also filled. Engineers and technicians, with the aid of electronic equipment, constantly observe the vehicle to make sure it will work properly. When all is ready, the crawler moves the service tower away from the pad.

Before the launch, rocket engineers follow a *countdown* (schedule) to be sure that all preparations for the launch are completed at their proper times. As the countdown nears its end, a computer often takes control. But technicians in the safety of the *launch control center* can resume control of the countdown if necessary. They watch the pad with television cameras. Finally, the first stage engines ignite. A set of arms holds the vehicle until its engines build up enough thrust to lift it off the pad. Then the vehicle roars into the air.

Crawler Takes Saturn V From Assembly Building.

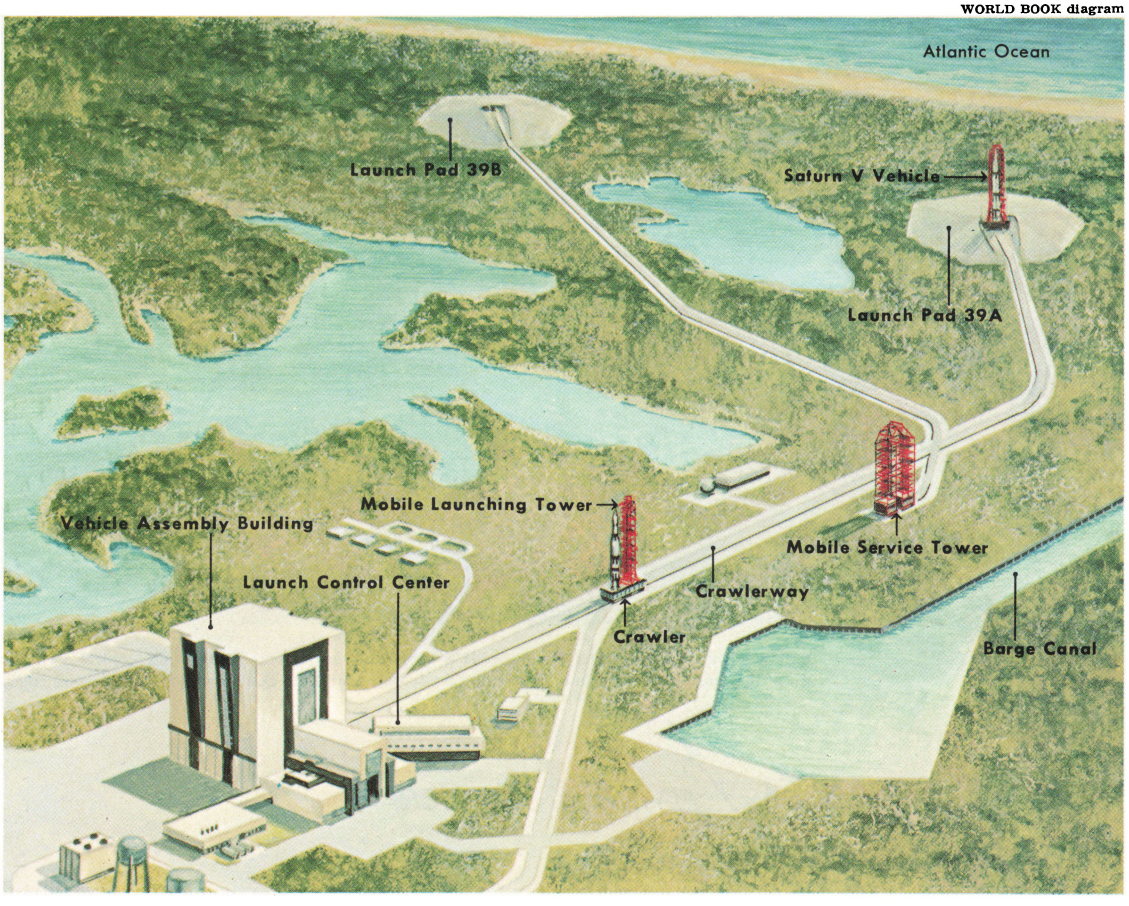


On the Launch Pad



The Apollo Spaceport includes the Vehicle Assembly Building, where the Apollo spacecraft and the Saturn V launch vehicle are connected. The Saturn V is brought to the spaceport on barges. After assembly, the spacecraft and launch vehicle are carried by a crawler to the launch pad. A service tower, from which technicians work, stands next to the spacecraft and launch vehicle until just before launch.

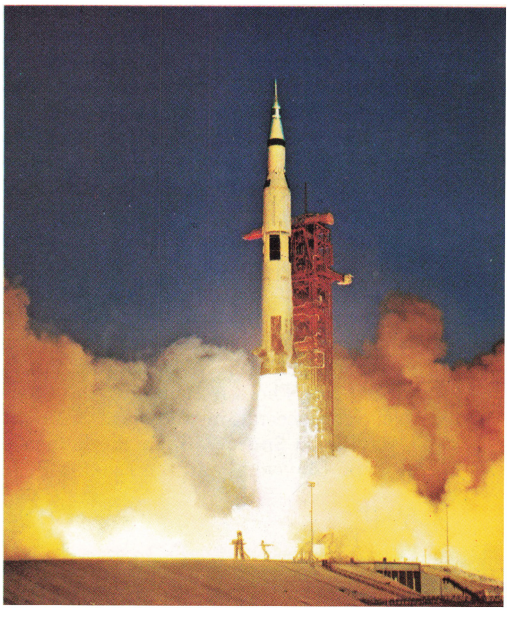
WORLD BOOK diagram

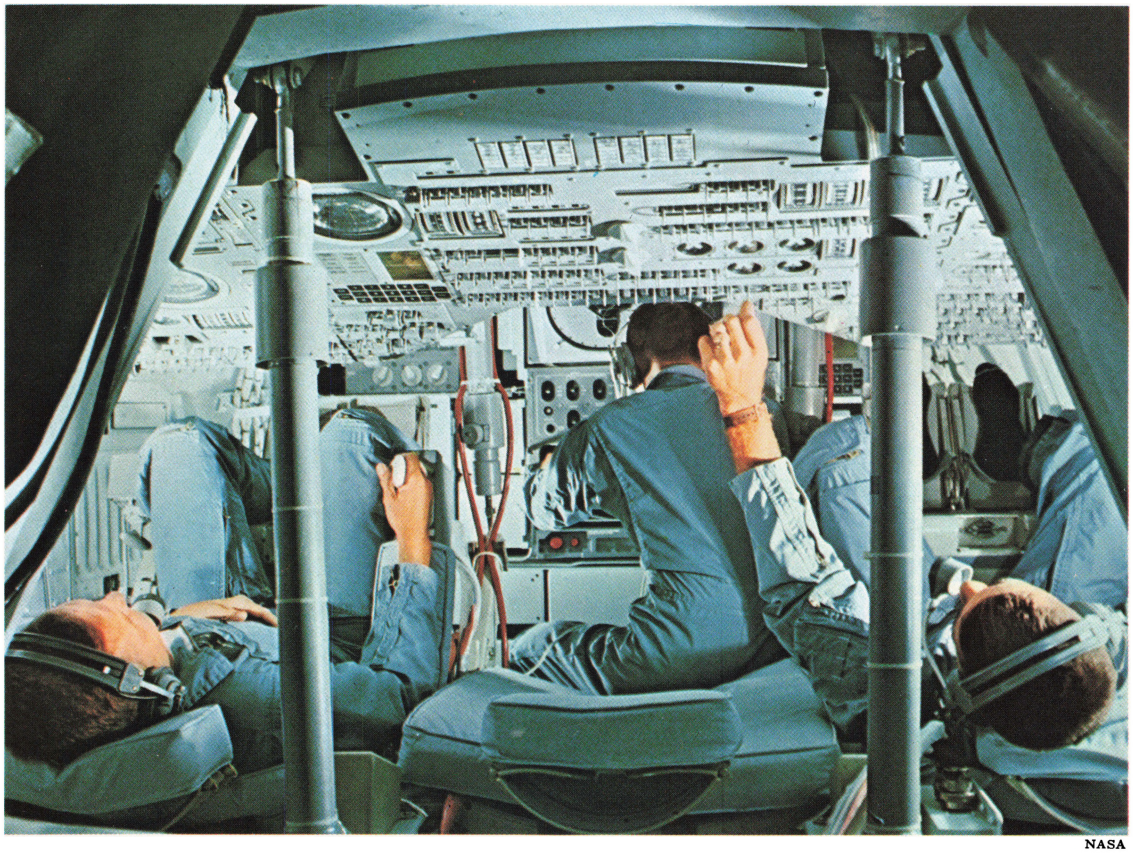


Technicians Wait in Launch Control Center.

Liftoff!

NASA





NASA

The Interior of an Apollo Spacecraft is lined with instrument panels and control switches. Each of the three astronauts in the command module operates the equipment located near his couch.

SPACE TRAVEL / *FLYING A SPACECRAFT*

Before the Flight. The astronauts start to get ready for a space flight many hours before the launch vehicle lifts off the pad. First, they get a physical examination to make sure they are in shape for the flight. Then they put on their space suits. The suits supply oxygen and protect them from the deadly vacuum of space if the air pressure inside the spacecraft drops. Astronauts wear their suits during lift-off for extra safety, and must wear them to "walk" in space or explore the moon's surface. They usually remove the space suits while they are sealed in the spacecraft and fly in the less bulky flight coveralls.

About two hours before the countdown ends, the astronauts ride in a special truck to the launch pad. An elevator in the mobile launch tower lifts them to the spacecraft poised atop the launch vehicle. Technicians help them into the craft and connect their suits to the oxygen supply, cooling system, and electrical equipment. The astronauts use the time before lift-off to check spacecraft instruments.

Piloting a Spacecraft. In the launch control center at Cape Canaveral and the Lyndon B. Johnson Space Center near Houston, tension mounts as *T-zero* (lift-off time) approaches. A few seconds before the countdown ends, the rocket's first stage engines roar to life. At T-zero, the vehicle lifts off. It rises slowly at first, then gains speed and streaks into the sky. The flight has begun, but the astronauts are not yet piloting their spacecraft. The launch vehicle's own guidance system controls the engines that lift and steer the rocket.

As the spacecraft gains altitude, the force of the accelerating rocket pushes the astronauts back in their couches. The acceleration makes them weigh 4 to 5 times as much as they do on the earth. About 6 minutes after lift-off, the spacecraft is in orbit. It is about 100 miles (160 kilometers) above the earth and traveling about 17,000 miles (27,000 kilometers) per hour.

The rocket's first and second stages have fallen back to earth. On some flights, the third stage remains attached to the spacecraft. On other flights, it separates, but orbits near the spacecraft for a time. Now, no force at all pushes the astronauts into their couches. They are weightless and orbiting freely through space along the same path as their spacecraft. Unless they

strap themselves to their couches, they will float inside the cabin.

For the first time during the flight, the astronauts can fly the spacecraft themselves. They steer the craft by moving a small control stick, similar to that in an airplane. Moving the stick fires small rocket motors. The motors rotate the craft in the direction the stick is moved. With a second stick, the astronauts steer the craft to *rendezvous* (meet) with other spacecraft or to change the spacecraft's course. On flights to the moon, the Apollo command module must rendezvous and *dock* (link together) with the Apollo lunar module twice.

The small rocket motors are not powerful enough to send a spacecraft to the moon or to bring it back to the earth. To make large changes in speed and direction, the astronauts need a larger rocket engine. They use either the engine in the attached third stage, or the engine in the service module.

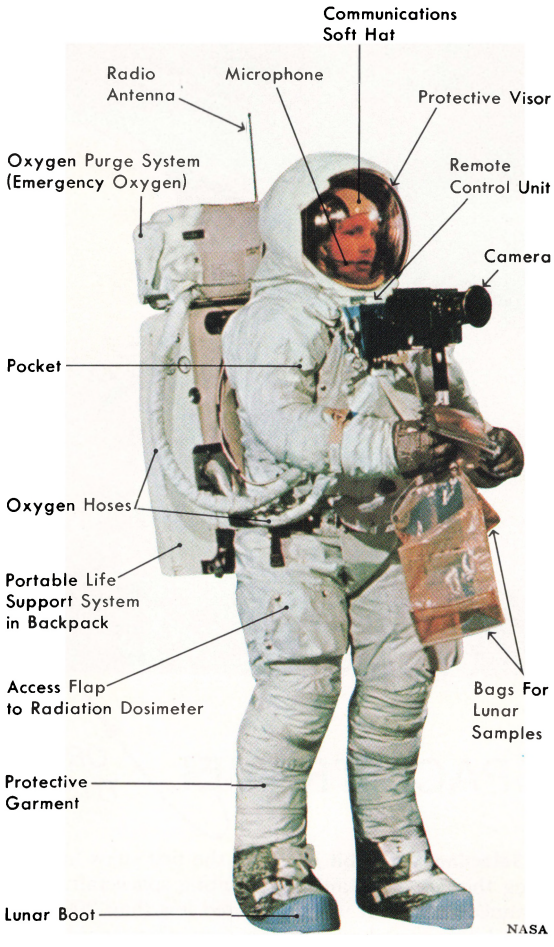
The astronauts must know the spacecraft's position at all times. In flights around the earth, the navigator receives radio information from tracking stations concerning his position. He also sights landmarks on the earth. On flights to the moon or planets, astronauts will miss their target unless they know which way and how fast they are traveling. The navigator uses special telescopes in the spacecraft to determine the position of certain stars in relation to landmarks on the moon. He puts this information into a computer that finds the spacecraft's position.

Scientific Duties. Astronauts are scientific explorers as well as pilots. In the early 1960's, almost everything the astronauts did in orbit told scientists something new about manned space travel. For example, no one knew how well men could work when they were weightless. The early flights proved that men could work in space.

Scientists ask astronauts to perform experiments so they can learn more about man's ability to live and work in space. In one test, astronauts pulled rubber exercise ropes to test methods of keeping physically fit during long periods of weightlessness. Astronauts also do experiments to learn more about space and our solar system. On the moon, they set up scientific equipment and bring back rock samples for more study.

Living in a Spacecraft. Food the astronauts eat is either *freeze-dried* (frozen and the water removed) or concentrated to save space and weight. The freeze-dried food—chicken and gravy or chocolate pudding, for example—comes in tube-shaped plastic bags. The astronaut injects hot or cold water into one end of the bag from a water supply gun in the spacecraft. He mixes the food and water in the bag for several minutes, then cuts off one end of the bag and squeezes the food into his mouth. Concentrated food—sugar cookies, for example—needs no water. It comes in bite-size pieces. The astronaut drinks water through a tube connected to the spacecraft water supply. Astronauts must eat and drink this way to keep crumbs and drops of liquids from floating inside the spacecraft.

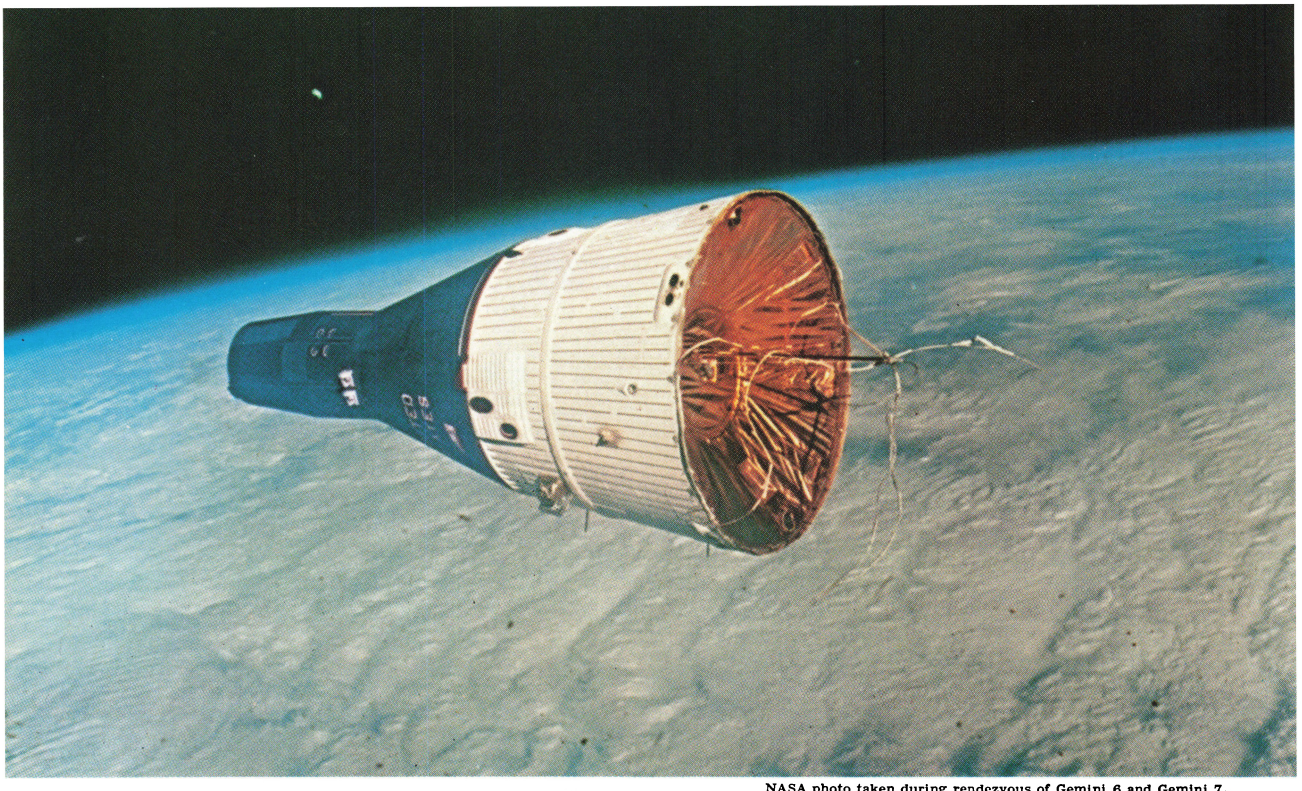
Astronauts can sleep strapped to their couches. But in the Apollo spacecraft, they have special sleeping bags under their couches. They can sleep in the bags without floating. Some astronauts say they have trouble going to sleep on their first night in space. But sleeping pills are provided for them.



An Astronaut's Space Suit has layers of protective fabric. While outside the spacecraft, he wears more protective garments and a backpack containing all equipment needed to support life.

Special systems in the craft dispose of body wastes. Liquid wastes are pumped outside. Solid wastes are disinfected and stored in plastic bags.

Re-Entry. A spacecraft returning to the earth from the moon must slow down before entering the atmosphere or it will burn up. It must also be in a certain *attitude* (position) with its blunt end pointing forward before firing its retrorockets. These rockets slow the craft to a safe speed for re-entry. The astronauts sit with their backs toward the blunt end and feel the push of the retrorockets as the spacecraft slows down. The spacecraft falls closer to the earth and enters the atmosphere. The astronauts' bodies begin to feel heavy again. The craft is still moving so fast it needs a heat shield to protect the astronauts from the intense heat. The heat *ionizes* (electrically charges) the air around the craft and blocks all radio communications with the astronauts for several minutes. Then the spacecraft releases big parachutes that carry it gently to the earth.



NASA photo taken during rendezvous of Gemini 6 and Gemini 7.

Orbiting the Earth at a height of 100 miles (160 kilometers), an astronaut can see blankets of clouds over the ocean, the blue band of the atmosphere curving around the horizon, and the black sky of space.

SPACE TRAVEL / *ORBITING THE EARTH*

Selecting the Orbit is one of the first steps in planning the launch of an earth-orbiting spacecraft. Early manned spacecraft usually orbited less than 200 miles (320 kilometers) high. In this way, they avoided the radiation in the Van Allen belts. A communications satellite may orbit at a much greater distance in order to serve many ground stations.

Most orbiting spacecraft do not stay the same distance from the earth all the time. Their orbits have the shape of a flattened circle called an *ellipse*. One end of the ellipse comes closer to the earth than the other. The point closest to the earth is called the orbiting spacecraft's *perigee*. The farthest point is called the *apogee*. Many scientific satellites follow orbits that have a low perigee and a very high apogee. These satellites can explore a wide range of space.

Satellites may also be launched in various directions around earth. They may circle in an east-west direction, in line with the equator. Or, they may travel north and south, passing over the earth's poles. Most satellites travel in a direction between these extremes.

Launching a Spacecraft. When the launch vehicle blasts off, it lifts the spacecraft straight up for about a minute. Then the vehicle arches into the proper direction for the selected orbit. Finally, the vehicle's last stage fires to give the spacecraft the velocity it needs to go into orbit. The higher the orbit, the lower the speed needed to stay in orbit. For example, a spacecraft in a circular orbit 200 miles (320 kilometers) high must travel more than 17,000 miles (27,400 kilometers) per hour. But to orbit at 22,000 miles (35,400 kilometers), a spacecraft needs a speed of only about 6,900 miles (11,100 kilometers) per hour. However, a more powerful launch vehicle is needed to put a spacecraft in the higher orbit.

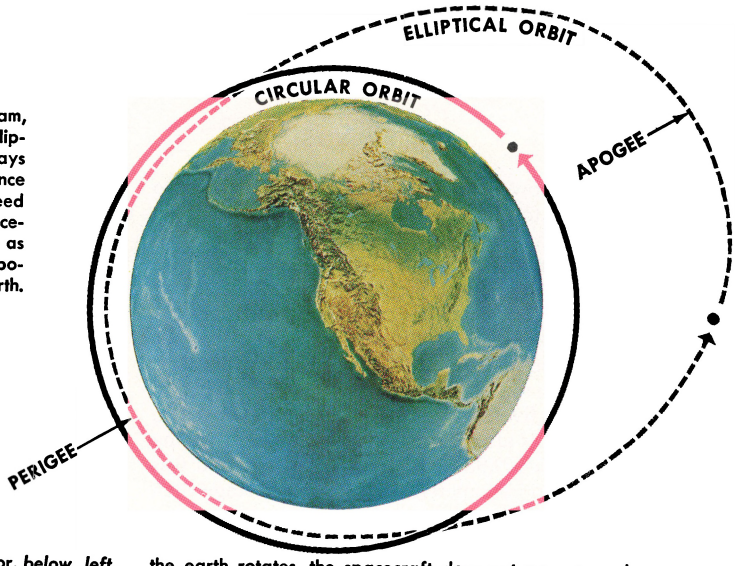
To place a spacecraft in orbit, the launching rockets must be carefully controlled. Each stage must burn for the exact length of time to give the spacecraft the right speed. Sensitive gyroscopes and other special devices guide the vehicle to keep it on course. Some vehicles are controlled by clockwork or magnetic tape devices. Many launch vehicles are controlled electronically from the ground. Signals from the vehicle tell a computer on the ground how the vehicle is working. The computer compares this information with the vehicle's planned operation. The computer then sends signals back to the vehicle to make the necessary corrections in speed or direction.

How a Spacecraft Stays in Orbit. Nothing "holds up" an orbiting spacecraft. Gravity keeps the spacecraft in orbit by pulling down on it. Without gravity, the spacecraft would shoot off into space in a straight line. But gravity pulls the spacecraft out of the straight path and causes it to curve around the earth.

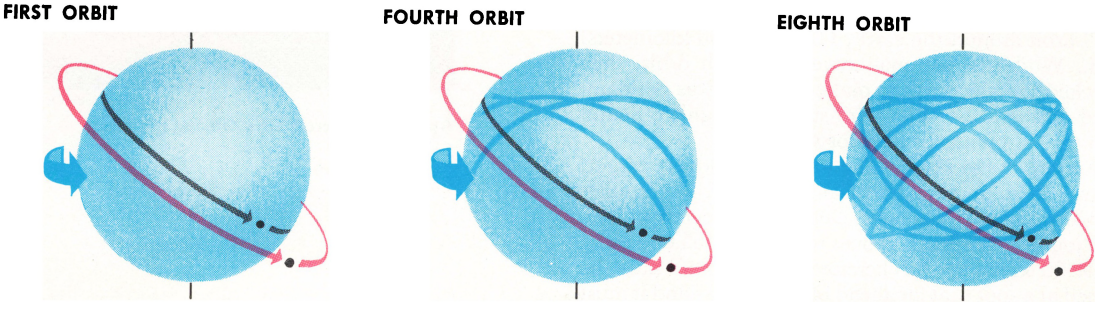
The force of gravity weakens as the distance from earth is increased. Near the earth, a strong gravitational force pulls a spacecraft and causes it to curve. There, the spacecraft must have a high speed. Otherwise it would curve too much and come closer and closer to earth. But at higher altitudes, gravity is not so strong. There, a spacecraft can travel more slowly and still keep from being pulled closer to earth.

Kinds of Earth Orbits

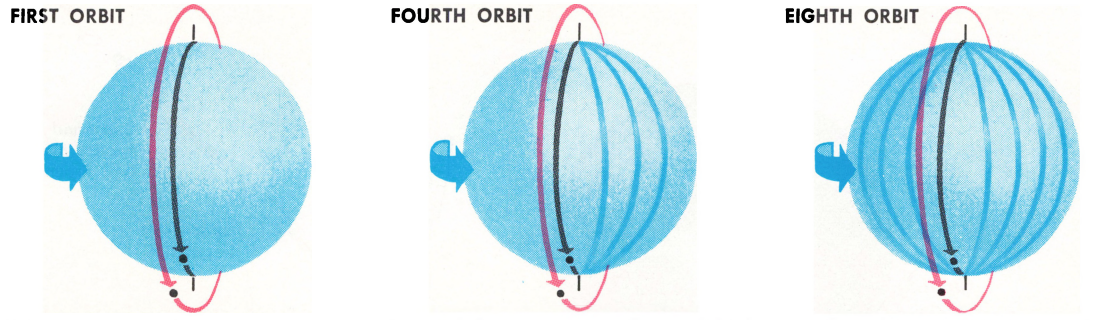
Circular and Elliptical Orbits. The diagram, *right,* shows the difference between circular and elliptical orbits. In a circular orbit, a spacecraft always travels at the same speed and stays the same distance from earth. In an elliptical orbit, a spacecraft's speed and distance from earth change continually. The spacecraft goes fastest at perigee and then slows down as it swings farther from earth. It travels slowest at apogee, but speeds up as it curves back closer to earth.



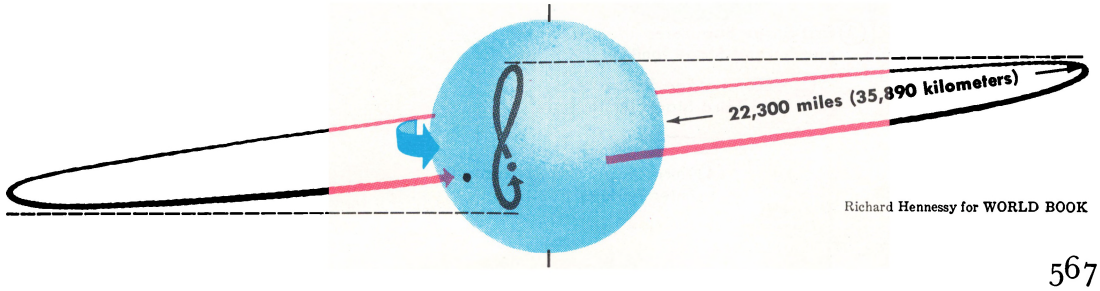
An Inclined Orbit forms an angle with the equator, *below, left.* In the diagrams, the red lines show the orbit, and the blue lines represent the spacecraft's path as mapped on the earth. Because the earth rotates, the spacecraft does not pass over the same points on earth during each orbit. As a result, the path of the spacecraft appears as crisscrossed lines on the earth, *right.*



A Polar Orbit carries a spacecraft over the north and south poles, as shown in the diagram, *below, left.* As the earth rotates, the spacecraft passes over different points on earth during each orbit, as shown *below, right.* A polar orbit is especially useful in weather satellites such as Nimbus. By orbiting almost directly over the poles, Nimbus can photograph the entire earth once a day.



A Synchronous Orbit carries a spacecraft around the earth once every day. The diagram, *below,* shows the path of a Syncom communications satellite. As mapped on earth, the satellite's path is a figure eight, because the orbit is slightly inclined. If the spacecraft were launched directly in line with the equator, it would stay above one spot on earth without moving north or south.



Richard Hennessy for WORLD BOOK

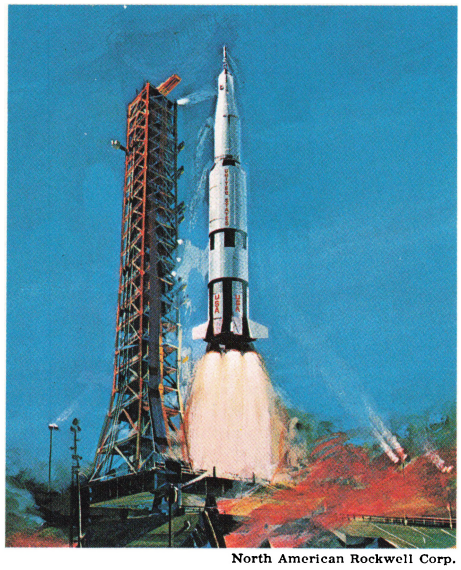
SPACE TRAVEL / *REACHING THE MOON*

Much more power is required to send a spacecraft to the moon than to put it in orbit around the earth. To reach the moon, a spacecraft must reach a speed of about 24,300 miles (39,110 kilometers) per hour. To reach this speed, an Apollo spacecraft was boosted into the sky by a Saturn V rocket. This section describes the Apollo missions of 1969 and the early 1970's.

The three Apollo astronauts, riding in the command module near the top of the vehicle, were forced back on their couches as five engines lifted them from the earth. About 2½ minutes after liftoff, the vehicle was traveling about 6,200 miles (9,980 kilometers) per hour and was about 41 miles (66 kilometers) high. The first stage then separated from the vehicle, and the second stage ignited.

The second stage carried the vehicle about 116 miles (187 kilometers) above the earth and boosted its speed to about 15,400 miles (24,780 kilometers) per hour. Then the second stage separated and the third stage ignited, sending the vehicle into a near-circular "parking" orbit around the earth, 118 miles (190 kilometers) high. While the astronauts were in earth orbit, they checked the spacecraft to make certain it was not damaged during liftoff. The third stage then ignited again, and the astronauts headed for the moon.

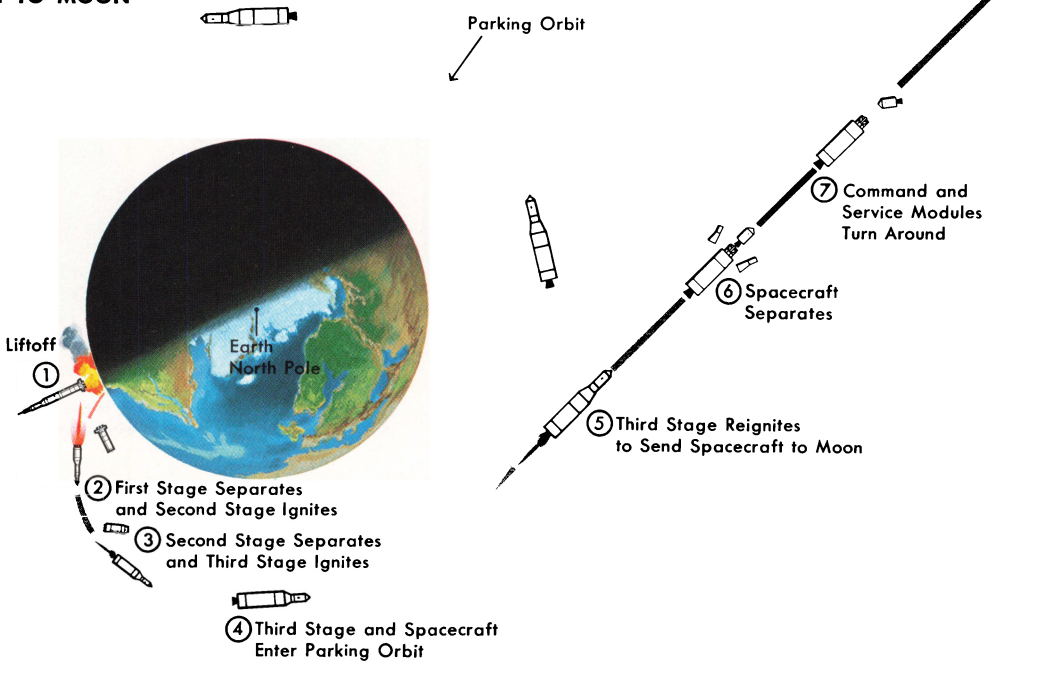
Aiming at the Moon. The moon is a moving target. It travels around the earth at more than 2,000 miles (3,200 kilometers) per hour. During a spacecraft's three-day journey, the moon moves more than 165,000 miles (265,500 kilometers). Therefore, a spacecraft must be aimed at a spot that far ahead of the moon—and it must reach this spot at exactly the same time the moon does.

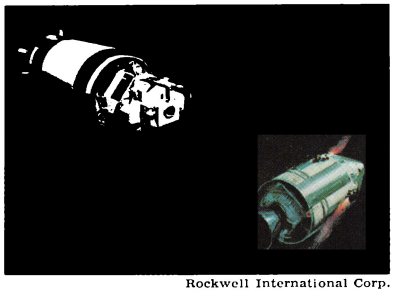


North American Rockwell Corp.

Apollo Spacecraft Lifts Off for the Moon

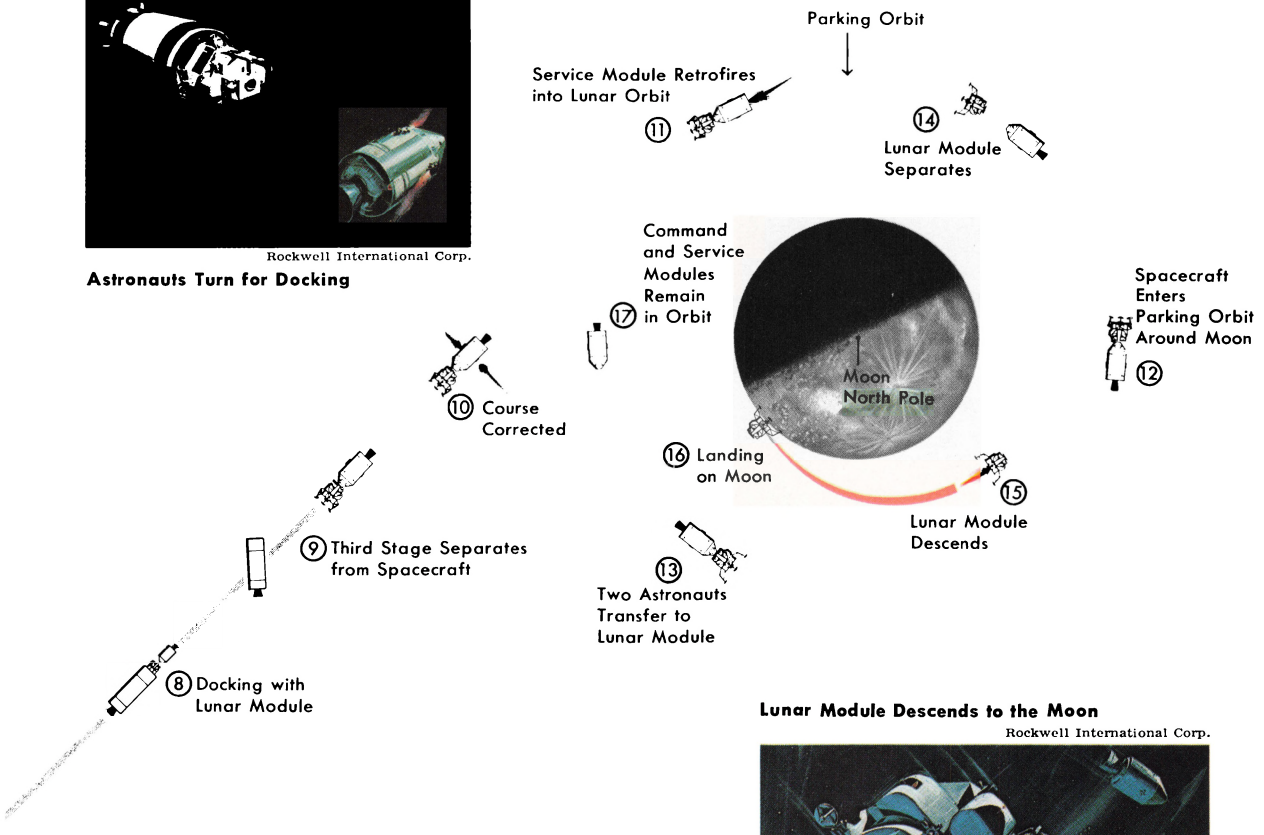
FROM EARTH TO MOON





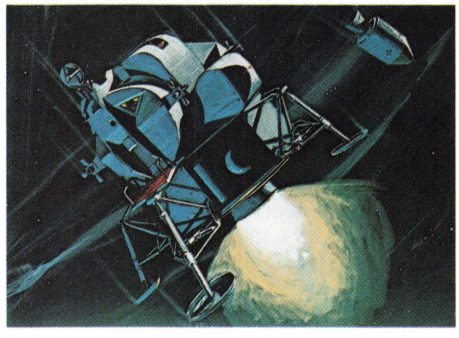
Rockwell International Corp.

Astronauts Turn for Docking



Lunar Module Descends to the Moon

Rockwell International Corp.



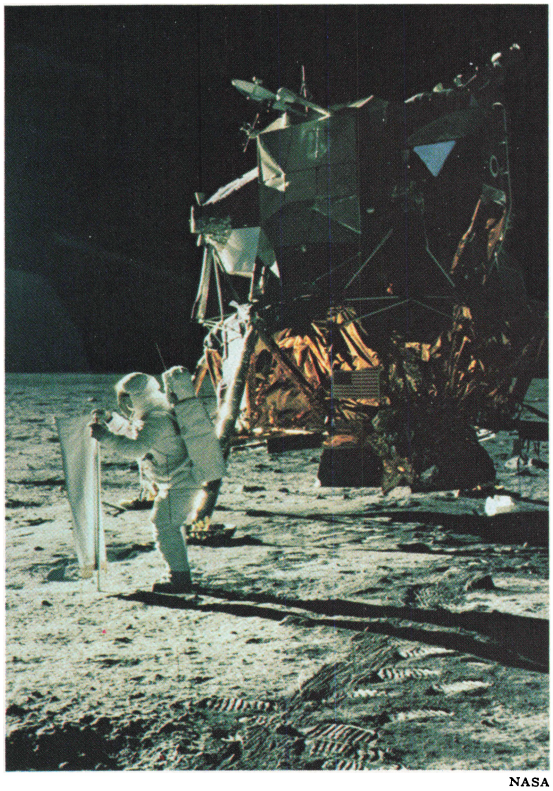
The third stage of the Apollo burned for about 5½ minutes, pushing the spacecraft toward the moon at about 24,300 miles (39,110 kilometers) per hour. After this burn, the astronauts turned the command and service modules around. Then they docked with the lunar module (LM), which was atop the third stage. Later, the third stage was disconnected from the LM.

As the spacecraft sped toward the moon, the navigator determined if the craft was on course. Using a *sextant* and a telescope, he measured the angle between a star and some landmark on the earth, or between a star and the moon's horizon. After measuring the angles to three stars, the navigator used a computer to determine the spacecraft's position in space. If the craft was off course, the crew could make one or more *mid-course corrections*. Small rocket motors were fired to bring the spacecraft back on course.

As the spacecraft traveled toward the moon, the earth's gravity slowed it down continuously. When the spacecraft reached a point about 215,000 miles (346,000 kilometers) from the earth, it had slowed to about 2,000 miles (3,200 kilometers) per hour. But at this point—only about 30,000 miles (48,000 kilometers) from the moon—the moon's gravity is stronger than the earth's, and the spacecraft began to pick up speed.

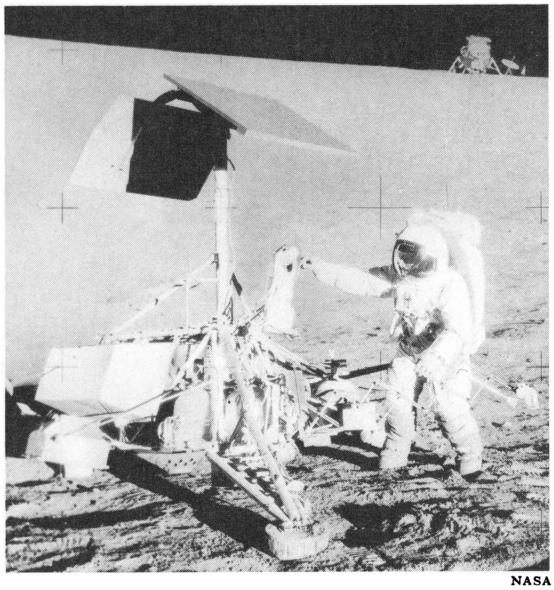
Orbiting the Moon follows the same principles as orbiting the earth. A spacecraft needs a certain speed to orbit at a certain altitude. The Apollo spacecraft had more speed than it needed to go into lunar orbit. Therefore, a rocket engine in the service module fired to slow the spacecraft and put it in orbit. Then two of the three astronauts entered the LM through a hatch.

Landing on the Moon. After the lunar module was carefully checked by the astronauts, it was separated from the command module. The command module, manned by the third astronaut, stayed in lunar orbit. The LM fired its engine and began its descent to the moon. Parachutes and wings could not be used to lower the craft. These devices need air to work, and there is no air on the moon. The LM carried a rocket engine that



NASA

A Solar Wind Experiment was set up by Apollo 11 astronaut Edwin E. Aldrin, Jr., above. The device captured atoms cast out by the sun. The astronauts brought the apparatus back with them.



NASA

***Surveyor 3* Spacecraft Parts,** above, were taken back to the earth by Apollo 12 astronauts Alan L. Bean and Charles Conrad, Jr. Scientists examined the parts to learn how conditions on the moon had affected them. The Apollo 12 lunar module, *Intrepid*, landed about 600 feet (180 meters) from *Surveyor 3* in the waterless Ocean of Storms near the moon's equator.

slowed the descent as the craft neared the surface.

Computers normally guided the LM, but the pilot could guide the craft if he wished. The astronauts could hover above the landing site for about a minute while they made certain that they could land safely. Probes extending from the legs of the LM indicated when it was 5 feet (1.5 meters) above the surface. The men then shut off the engine, and the craft landed on the moon.

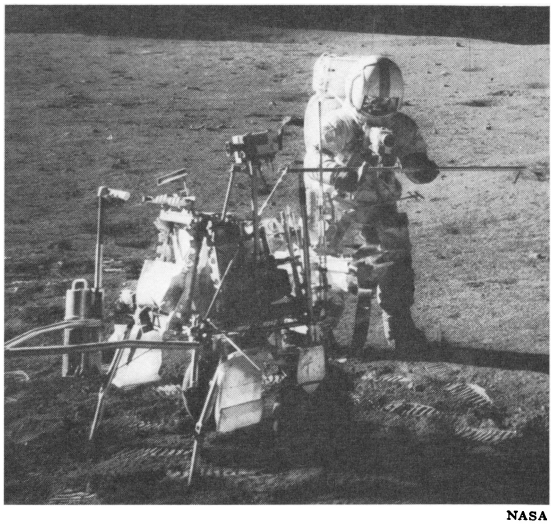
The astronauts would have been stranded if the LM were damaged beyond repair while landing. The LM had to lift them off the moon because the command module was not designed to land on the moon.

Exploring the Moon. After the Apollo lunar module landed on the moon, the two astronauts checked the LM to be sure it would get them back to the command module in lunar orbit. Before leaving the LM, each lunar explorer put on additional garments for protection against the moon's airless environment. A backpack worn outside the LM contained all the systems needed to support life.

The first men to set foot on the moon were U.S. astronauts Neil A. Armstrong and Edwin E. Aldrin, Jr. Their Apollo 11 lunar module, called *Eagle*, touched down on the rocky plain called the Sea of Tranquility on July 20, 1969. First Armstrong and then Aldrin stepped on the moon's surface. Aldrin described the view of the moon from the surface as "magnificent desolation." The astronauts quickly became adjusted to the gravity of the moon, which is only one-sixth as strong as the earth's.

Astronauts made six moon landings between 1969 and 1972. The Apollo 12 module, *Intrepid*, landed on the waterless Ocean of Storms on Nov. 19, 1969. It carried astronauts Charles (Pete) Conrad, Jr., and Alan L. Bean. Apollo 14 astronauts Alan B. Shepard, Jr., and Edgar D. Mitchell landed their module, *Antares*, near the Fra Mauro Crater on Feb. 5, 1971. Apollo 15 astronauts David R. Scott and James B. Irwin landed their module, *Falcon*, in the Apennines mountains on July 30, 1971. Apollo 16 astronauts John W. Young and Charles M. Duke, Jr., landed their module, *Orion*, in the Descartes region on April 20, 1972. Apollo 17 astronauts Eugene A. Cernan and Harrison H. Schmitt landed their module, *Challenger*, in the Taurus mountains on Dec. 11, 1972.

An important scientific task of the Apollo astronauts was the recovery of samples from the lunar surface for scientific study. Apollo 11 astronauts collected about 48 pounds (22 kilograms) of surface material on their one journey. Apollo 12 astronauts made two trips. On their second trip, Conrad and Bean walked about 600 feet (180 meters) to the unmanned *Surveyor 3* lunar probe that had landed in April, 1967. Apollo 15 astronauts Scott and Irwin became the first men to explore a rugged, mountainous area. They also were the first astronauts to travel on the moon in a vehicle. They drove their battery-powered *lunar rover* more than 17 miles (27 kilometers). Scott and Irwin collected 170 pounds (77 kilograms) of lunar samples. They drilled 10 feet (3 meters) into the moon to obtain some of them. Apollo 17 astronauts Cernan and Schmitt returned with over 200 pounds (91 kilograms) of samples. Scientists



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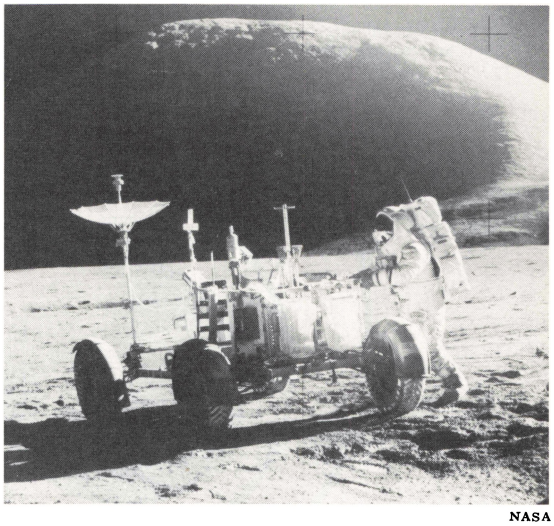


NASA

An Apollo 14 Astronaut, Alan B. Shepard, Jr., assembles tools used to gather lunar samples, *above left*. He stands beside an equipment transporter that carried the astronauts' tools across the surface of the moon. Apollo 14 landed in the region of the Fra Mauro Crater and brought back lunar samples that differed in some ways from those gathered during earlier moon landings.

A Lunar Rover, *above right,* carried Apollo 15 astronauts David R. Scott and James B. Irwin more than 17 miles (27 kilometers) on the moon. The vehicle enabled the men to travel farther from their lunar module than any previous Apollo astronauts. Irwin is shown working with the rover near the landing site. Mount Hadley, in the Apennines range, rises in the background.

An Apollo 16 Astronaut, Charles M. Duke, Jr., collects lunar samples beside the Plum Crater in the moon's Descartes region, *right*. Duke and astronaut John W. Young landed their lunar module, *Orion*, nearby and rode across the lunar surface to this site in the lunar rover parked behind the crater. Reflections of the sun in the camera lens appear as white spots above Duke's head.

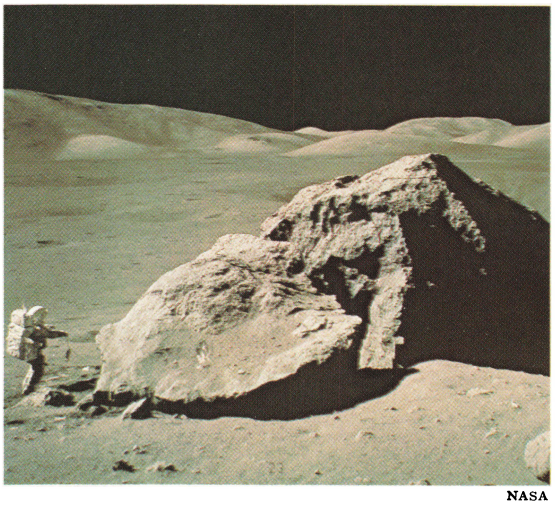
A Giant Boulder, *below right,* yielded valuable lunar samples to Apollo 17 scientist-astronaut Harrison H. Schmitt. Astronaut Eugene A. Cernan took this photograph as the two men explored near their landing site in the Taurus Mountains.

NASA

thought some of them contained evidence of volcanic activity. Schmitt was the first scientist-astronaut to explore the moon. He has a Ph.D. degree in geology.

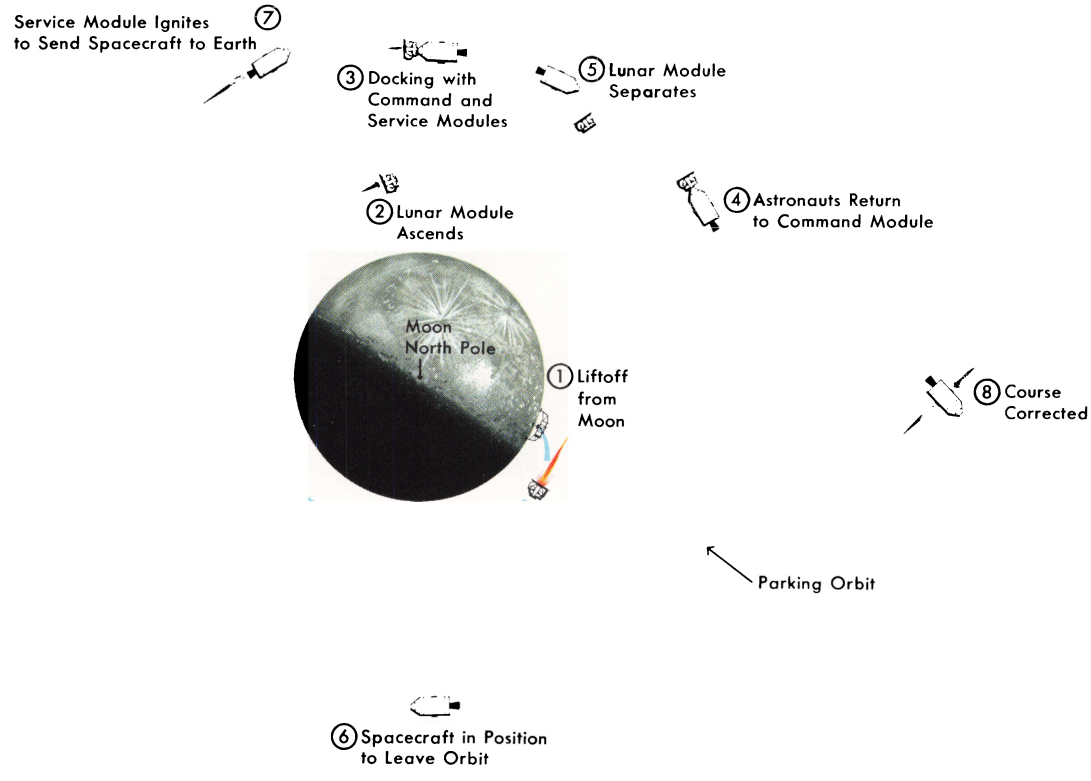
Apollo astronauts also set up equipment to perform scientific experiments. One device—a screen of aluminum foil 1 by 3 feet (30 by 91 centimeters)—captured particles of the solar wind shot out from the sun (see SOLAR WIND). Apollo astronauts also set up instruments called *seismometers* to detect earthquakelike disturbances in the moon. At least one set of vibrations detected by a seismometer was thought to have been caused by a moonquake. After the astronauts were aboard their command modules, they sent the ascent stage of their lunar modules crashing into the moon to create vibrations for the seismometers to detect.

Another device left on the moon was a reflector for a *laser beam* (an extremely intense beam of light). Scientists use it to measure the distance to the moon by timing pulses of light sent from a laser on the earth and reflected back to the earth.



NASA

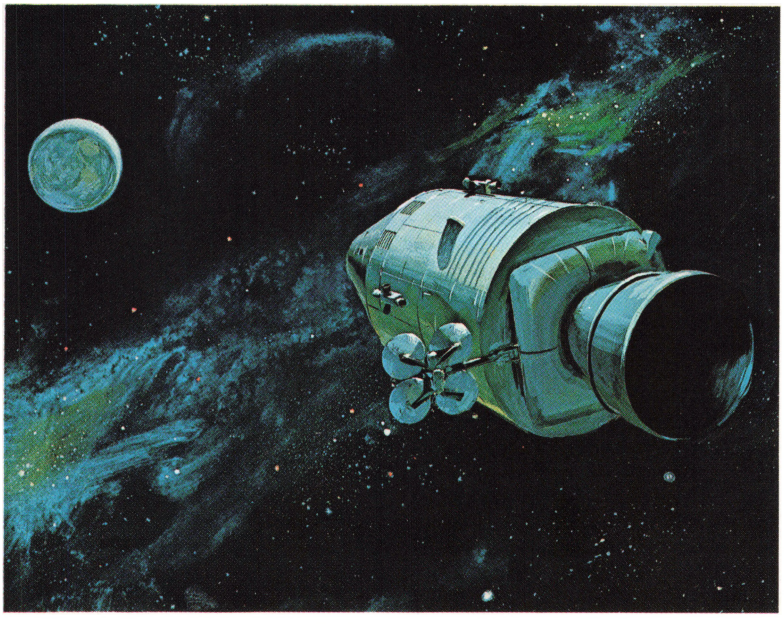
FROM MOON TO EARTH



North American Rockwell Corp.

Liftoff from the Moon

North American Rockwell Corp.



Returning to Earth

When the astronauts lifted off from the moon, they left behind their backpacks, walking boots, and other equipment that was no longer necessary. Leaving these items lightened the load of the LM ascent stage for its trip back up to the command module.

Returning to Earth. The ascent stage of the lunar module lifted off the moon using the descent stage as a launching platform. The LM first went into an orbit that was lower than that of the command module. When the distance and angle between the two spacecraft were just right, the LM engine was fired and the craft soared into the same orbit as the command module, about 69 miles (111 kilometers) above the moon.

The command module pilot maneuvered to dock with the LM. After docking, the pressures in the two craft were equalized, and the hatch between them was opened. The moon samples and the equipment to be returned to the earth were transferred to the command module. All equipment that was not to be returned to the earth was placed in the lunar module. The LM crew then moved into the command module, and the LM was disconnected.

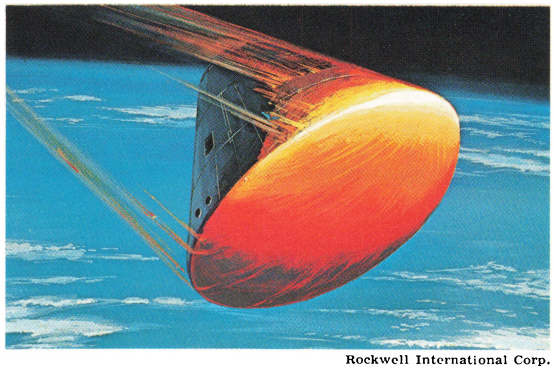
The engine of the service module was fired to push the astronauts out of lunar orbit and send them toward the earth. The trip home resembled the trip to the moon. Mid-course corrections were made if necessary. Before the command module entered the earth's atmosphere, the service module was disconnected.

The command module turned around before it entered the atmosphere. The pressure of the atmosphere against the blunt end helped slow the craft.

The command module had to meet the pressure of the earth's atmosphere at a certain angle to make a safe landing. If the angle was too shallow, the craft would bounce off the atmosphere and go back into space. If the angle was too steep, the friction between the atmosphere and the spacecraft would generate too much heat, and the craft would burn up. During a normal reentry, the special plastic heat shield on the command module might reach a temperature of 4200° F. (2316° C). The temperature inside the cabin remained at about 80° F. (27° C).

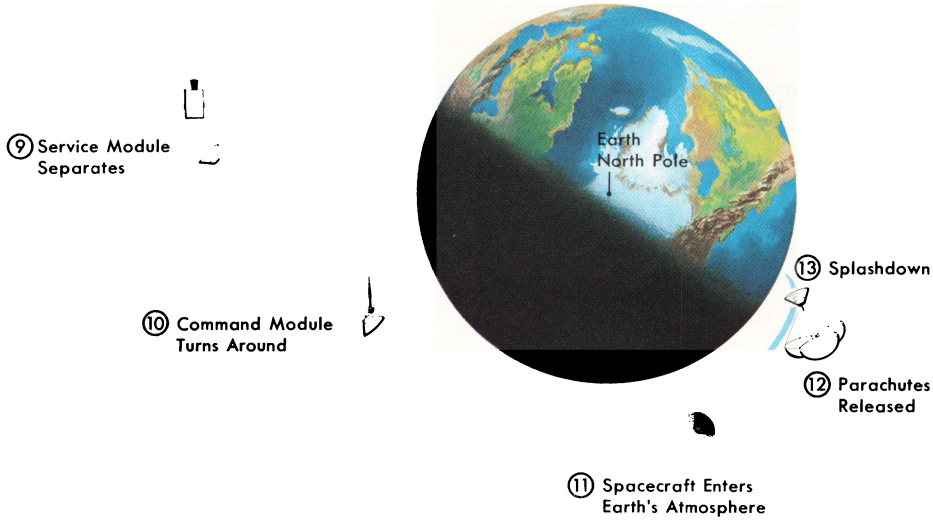
At about 23,300 feet (7,102 meters), special parachutes called *drogues* were released. The drogues slowed and steadied the spacecraft. At about 10,500 feet (3,200 meters), the main parachutes were released. The craft hit the water at about 22 miles (35 kilometers) per hour.

After Apollo 11 returned to the earth, the lunar material, the astronauts, and the equipment that was exposed to the lunar atmosphere were placed in isolation. The purpose of the isolation period, which lasted about 17 days for the astronauts, was to determine whether any germs or other harmful material had been brought from the moon. No harmful material was found.



Rockwell International Corp.

Heading for Splashdown



NASA

After Splashdown, the Apollo 11 astronauts were scrubbed with disinfectant to kill possible moon germs. The air bags righted the spacecraft in the water, and the collar helped keep it afloat.

THE LOG OF APOLLO 11

July 16, 1969

9:32 A.M.† Apollo 11 lifts off launch pad 39A at Cape Kennedy (now Cape Canaveral).
9:35 A.M. The first stage of the Saturn V launch vehicle separates, and the second stage ignites.
9:41 A.M. The second stage separates and the third stage ignites.
12:16 P.M. The third stage engine reignites to send the spacecraft to the moon.
12:49 P.M. The command module, called *Columbia,* and the service module separate from the lunar module, called *Eagle,* and the third stage.
12:57 P.M. *Columbia* and the service module dock with *Eagle.*
1:49 P.M. The third stage separates from the spacecraft.

July 17, 1969

12:16 P.M. The astronauts make a minor correction in their course.

July 18, 1969

11:11 P.M. Apollo 11 enters the moon's sphere of gravitational influence, 214,102 miles (344,564 kilometers) from the earth.

July 19, 1969

1:21 P.M. The retrorocket in the service module fires to slow the spacecraft into lunar orbit, 244,930 miles (394,177 kilometers) from the earth.

July 20, 1969

1:45 P.M. *Eagle,* with Armstrong and Aldrin aboard, separates from *Columbia.*
4:17 P.M. *Eagle* lands on the moon on the rocky plain called the Sea of Tranquility.
10:39 P.M. The hatch of *Eagle* is opened.
10:56 P.M. Armstrong sets foot on the moon.
11:14 P.M. Aldrin joins Armstrong on the moon. The two astronauts collect lunar samples and set up scientific experiments.

July 21, 1969

12:57 A.M. Aldrin climbs back into *Eagle* and helps Armstrong load the lunar samples.
1:09 A.M. Armstrong re-enters *Eagle.*
1:11 A.M. *Eagle's* hatch is closed.
1:54 P.M. *Eagle* lifts off the moon.
5:35 P.M. *Eagle* docks with *Columbia,* and Armstrong and Aldrin rejoin Collins.
7:41 P.M. *Eagle* is separated from *Columbia.*

July 22, 1969

12:55 A.M. The rocket engine in the service module fires to send the spacecraft back to the earth, 235,000 miles (378,200 kilometers) away.
4:01 P.M. The astronauts make a minor course correction.

July 24, 1969

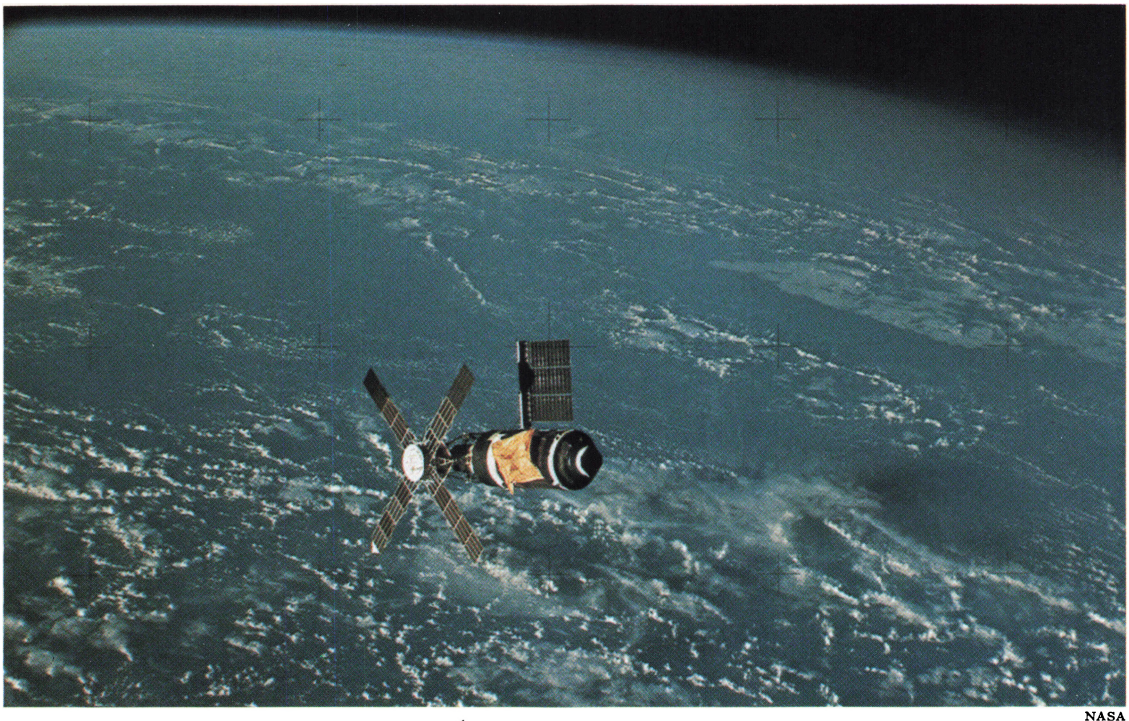
12:20 P.M. The service module separates from *Columbia* shortly before re-entering the earth's atmosphere.
12:35 P.M. *Columbia* re-enters the earth's atmosphere.
12:44 P.M. Parachutes are released to slow the spacecraft.
12:50 P.M. Splashdown! The journey of Apollo 11 ends.

†All times are Eastern Daylight-Saving Time.

MANNED SPACE FLIGHTS

Date Launched	Astronaut or Cosmonaut	Spacecraft	Country	Revolutions	Time of Flight
1961 Apr. 12	Y. Gagarin	Vostok I	Russia	1	1 hr. 48 min.
May 5	A. Shepard, Jr.	*Freedom 7*	U.S.A.	Suborbital	15 min.
July 21	V. Grissom	*Liberty Bell 7*	U.S.A.	Suborbital	16 min.
Aug. 6	G. Titov	Vostok II	Russia	16	1 day, 1 hr. 18 min.
1962 Feb. 20	J. Glenn, Jr.	*Friendship 7*	U.S.A.	3	4 hr. 55 min.
May 24	S. Carpenter	*Aurora 7*	U.S.A.	3	4 hr. 56 min.
Aug. 11	A. Nikolayev	Vostok III	Russia	60	3 days, 22 hr. 22 min.
Aug. 12	P. Popovich	Vostok IV	Russia	45	2 days, 22 hr. 57 min.
Oct. 3	W. Schirra, Jr.	*Sigma 7*	U.S.A.	6	9 hr. 13 min.
1963 May 15	G. Cooper, Jr.	*Faith 7*	U.S.A.	22	1 day, 10 hr. 20 min.
June 14	V. Bykovsky	Vostok V	Russia	76	4 days, 23 hr. 6 min.
June 16	V. Tereshkova	Vostok VI	Russia	45	2 days, 22 hr. 50 min.
1964 Oct. 12	V. Komarov, K. Feoktistov, B. Yegorov	Voskhod I	Russia	15	1 day, 0 hr. 17 min.
1965 Mar. 18	P. Belyayev, A. Leonov	Voskhod II	Russia	16	1 day, 2 hr. 2 min.
Mar. 23	V. Grissom, J. Young	*Molly Brown*	U.S.A.	3	4 hr. 53 min.
June 3	J. McDivitt, E. White II	Gemini 4	U.S.A.	62	4 days, 1 hr. 56 min.
Aug. 21	G. Cooper, Jr., C. Conrad, Jr.	Gemini 5	U.S.A.	120	7 days, 22 hr. 56 min.
Dec. 4	F. Borman, J. Lovell, Jr.	Gemini 7	U.S.A.	206	13 days, 18 hr. 35 min.
Dec. 15	W. Schirra, Jr., T. Stafford	Gemini 6	U.S.A.	16	1 day, 1 hr. 51 min.
1966 Mar. 16	N. Armstrong, D. Scott	Gemini 8	U.S.A.	7	10 hr. 41 min.
June 3	T. Stafford, E. Cernan	Gemini 9	U.S.A.	44	3 days, 0 hr. 21 min.
July 18	J. Young, M. Collins	Gemini 10	U.S.A.	43	2 days, 22 hr. 47 min.
Sept. 12	C. Conrad, Jr., R. Gordon, Jr.	Gemini 11	U.S.A.	44	2 days, 23 hr. 17 min.
Nov. 11	J. Lovell, Jr., E. Aldrin, Jr.	Gemini 12	U.S.A.	59	3 days, 22 hr. 35 min.
1967 Apr. 23	V. Komarov	Soyuz I	Russia	17	1 day, 2 hr. 37 min.
1968 Oct. 11	W. Schirra, Jr., D. Eisele, W. Cunningham	Apollo 7	U.S.A.	163	10 days, 20 hr. 9 min.
Oct. 26	G. Beregovoi	Soyuz III	Russia	60	3 days, 22 hr. 51 min.
Dec. 21	F. Borman, W. Anders, J. Lovell, Jr.	Apollo 8	U.S.A.	Lunar flight	6 days, 3 hr. 1 min.
1969 Jan. 14	V. Shatalov	Soyuz IV	Russia	45	2 days, 23 hr. 23 min.
Jan. 15	B. Volynov, Y. Khrunov,* A. Yeliseyev*	Soyuz V	Russia	46	3 days, 0 hr. 56 min.
Mar. 3	J. McDivitt, R. Schweickart, D. Scott	Apollo 9	U.S.A.	151	10 days, 1 hr. 1 min.
May 18	T. Stafford, E. Cernan, J. Young	Apollo 10	U.S.A.	Lunar flight	8 days, 0 hr. 3 min.
July 16	N. Armstrong, E. Aldrin, Jr., M. Collins	Apollo 11	U.S.A.	Lunar landing	8 days, 3 hr. 19 min.
Oct. 11	V. Kubasov, G. Shonin	Soyuz VI	Russia	75	4 days, 22 hr. 42 min.
Oct. 12	A. Filipchenko, V. Gorbatko, V. Volkov	Soyuz VII	Russia	75	4 days, 22 hr. 41 min.
Oct. 13	V. Shatalov, A. Yeliseyev	Soyuz VIII	Russia	75	4 days, 22 hr. 50 min.
Nov. 14	C. Conrad, Jr., A. Bean, R. Gordon, Jr.	Apollo 12	U.S.A.	Lunar landing	10 days, 4 hr. 36 min.
1970 Apr. 11	J. Lovell, Jr., F. Haise, Jr., J. Swigert, Jr.	Apollo 13	U.S.A.	Lunar flight	5 days, 22 hr. 55 min.
June 1	A. Nikolayev, V. Sevastyanov	Soyuz IX	Russia	268	17 days, 16 hr. 59 min.
1971 Jan. 31	A. Shepard, Jr., E. Mitchell, S. Roosa	Apollo 14	U.S.A.	Lunar landing	9 days, 0 hr. 2 min.
Apr. 23	V. Shatalov, A. Yeliseyev, N. Rukavishnikov	Soyuz X	Russia	30	1 day, 23 hr. 46 min.
June 6	G. Dobrovolsky, V. Volkov, V. Patsayev	Soyuz XI and Salyut I	Russia	362	23 days, 18 hr. 22 min.
July 26	D. Scott, J. Irwin, A. Worden	Apollo 15	U.S.A.	Lunar landing	12 days, 7 hr. 12 min.
1972 Apr. 16	J. Young, C. Duke, Jr., T. Mattingly	Apollo 16	U.S.A.	Lunar landing	11 days, 1 hr. 51 min.
Dec. 7	E. Cernan, H. Schmitt, R. Evans	Apollo 17	U.S.A.	Lunar landing	12 days, 13 hr. 52 min.
1973 May 25	C. Conrad, Jr., J. Kerwin, P. Weitz	Skylab 1 and 2	U.S.A.	405	28 days, 0 hr. 50 min.
July 28	A. Bean, O. Garriott, J. Lousma	Skylab 1 and 3	U.S.A.	859	59 days, 11 hr. 9 min.
Sept. 27	V. Lazarev, O. Makarov	Soyuz XII	Russia	30	1 day, 23 hr. 16 min.
Nov. 16	G. Carr, E. Gibson, W. Pogue	Skylab 1 and 4	U.S.A.	1,214	84 days, 1 hr. 16 min.
Dec. 18	P. Klimuk, V. Lebedev	Soyuz XIII	Russia	119	7 days, 20 hr. 55 min.
1974 July 3	P. Popovich, Y. Artyukhin	Soyuz XIV and Salyut III	Russia	236	15 days, 17 hr. 30 min.
Aug. 26	G. Sarafanov, L. Demin	Soyuz XV	Russia	30	2 days, 0 hr. 12 min.
Dec. 2	A. Filipchenko, N. Rukavishnikov	Soyuz XVI	Russia	90	5 days, 22 hr. 24 min.
1975 Jan. 10	A. Gubarev, G. Grechko	Soyuz XVII and Salyut IV	Russia	436	29 days, 13 hr. 20 min.
May 25	P. Klimuk, V. Sevastyanov	Soyuz XVIII and Salyut IV	Russia	1,031†	63 days†
July 15	V. Brand, D. Slayton, T. Stafford	Apollo**	U.S.A.	148	9 days, 1 hr. 28 min.
	A. Leonov, V. Kubasov	Soyuz XIX**	Russia	97†	5 days, 21 hr. 46 min.†

*Transferred to Soyuz IV in orbit
†Approximate figures
**Joint U.S.-Soviet mission involving rendezvous and docking



NASA

The *Skylab 1* Space Station was the first U.S. manned space laboratory. It was orbited about 270 miles (435 kilometers) above the earth in 1973. A solar panel and some shielding material were lost during launch, but the three astronauts repaired the station.

SPACE TRAVEL / *SPACE STATIONS*

A space station is a special kind of earth satellite. It is designed so that many men can live and work in orbit for a longer time than they could spend in an ordinary, crowded spacecraft. As a result, a space station must have living quarters for its crew and must be able to carry enough food, oxygen, and water to supply them for weeks or months. One crew can replace another without disturbing the work of the station. A space station functions as a laboratory for engineers and scientists. It may also serve as an assembly base and a stopping-off place for flights to the moon or planets.

There are several ways that a space station can be built and launched. One way is to launch a station that has been built in one piece. The Russian experimental station *Salyut* was launched this way in 1971. Manned Soyuz spacecraft later docked with it, and cosmonauts performed experiments aboard the station. The United States *Skylab* experimental space station is a modified third stage of a Saturn V rocket. The first two stages place it in orbit. Astronauts enter the *Skylab* from an Apollo spacecraft that has docked with it. *Skylab 1* was launched in 1973. The first group of three astronauts carried out experiments in it for 28 days. Two more groups of astronauts planned to live in the *Skylab* for up to 59 days.

Another way to build a space station calls for the separate launching of several sections of the station. These sections are then connected in orbit.

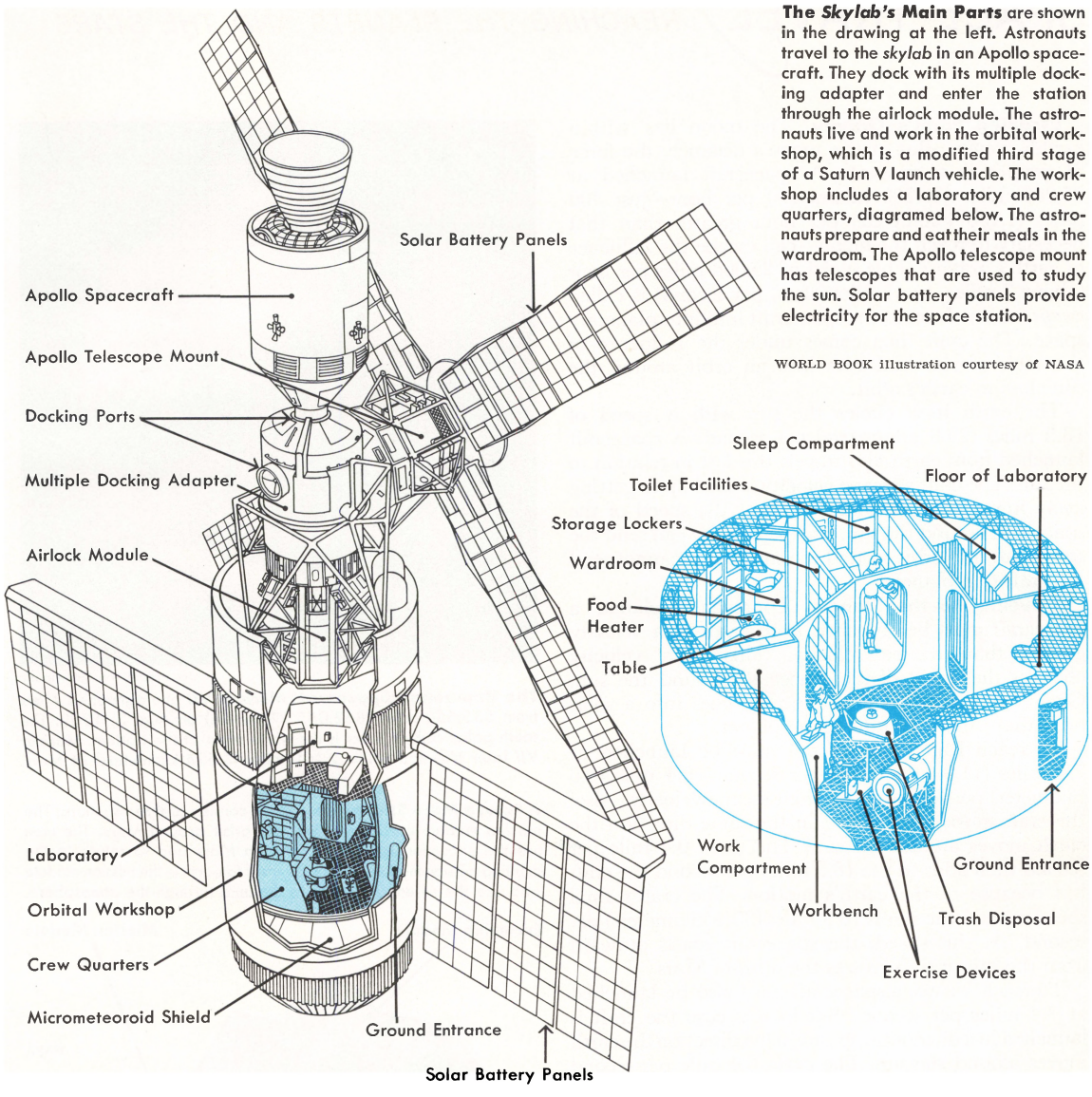
An operating space station requires some way to reach it frequently to change crews and to provide fresh supplies and research equipment. The United States is designing a space shuttle that could fly back and forth between the earth and a space station many times. Present rockets can be used only once. United States space scientists plan to have the shuttle in use by the early 1980's.

Space Station Laboratories can be used to study the stars, the sun, the solar wind, and the earth's upper atmosphere and magnetic field. Telescopes in the station can reveal much more about the universe than telescopes on earth. There is no atmosphere to dim an astronomer's view of the stars and galaxies.

Physicists can perform experiments to check the laws of nature and to test scientific theories. For example, they may compare the time kept by atomic clocks in the station to clocks on earth. This experiment would test Einstein's theory of relativity.

Biologists can use a space laboratory to learn more about the growth of plants and animals. On earth, all living things are affected by gravity, by the regular changes of day and night, and even by the attraction of the moon. Such forces may produce *biological rhythms* in plants and animals. But many of these forces would not affect living things in a space station. As a result, plants and animals might develop differently.

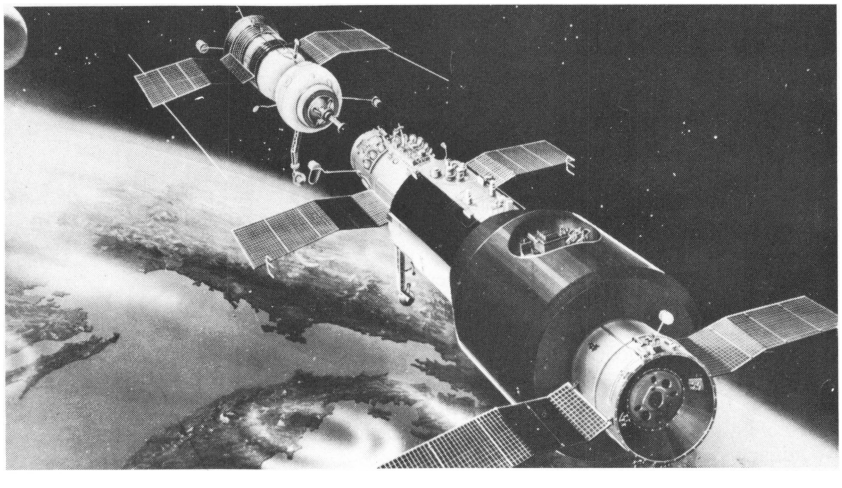
Stopping-Off Places for Spaceships. The launch into orbit uses up most of a space vehicle's fuel. After reaching orbit, a spaceship could stop at a space station and pick up more fuel. It could then continue its journey deeper into space.



The *Skylab's* Main Parts are shown in the drawing at the left. Astronauts travel to the *skylab* in an Apollo spacecraft. They dock with its multiple docking adapter and enter the station through the airlock module. The astronauts live and work in the orbital workshop, which is a modified third stage of a Saturn V launch vehicle. The workshop includes a laboratory and crew quarters, diagramed below. The astronauts prepare and eat their meals in the wardroom. The Apollo telescope mount has telescopes that are used to study the sun. Solar battery panels provide electricity for the space station.

WORLD BOOK illustration courtesy of NASA

Sovfoto



Salyut, an experimental Russian space station, was placed in orbit in 1971. Cosmonauts reached the station in a Soyuz spacecraft like the one pictured in the background. Several three-man teams of cosmonauts visited the station. They conducted experiments to learn how well men can live in space for long periods. The cosmonauts also grew plants and took pictures of the earth. One flight to *Salyut,* the *Soyuz* XI mission, ended in tragedy when the three cosmonauts died while returning to the earth. Their spacecraft hatch did not close properly, and their oxygen leaked into space.

Escaping Earth's Gravity. The moon lies within earth's gravity. But at the moon's distance, the force of gravity is very weak. A spacecraft launched at 25,000 miles (40,200 kilometers) per hour—just 700 miles (1,100 kilometers) per hour greater than that necessary to reach the moon—can escape the influence of earth's gravity. This speed of 25,000 miles per hour (about 7 miles, or 11 kilometers, per second) is called *escape velocity*. It sends the spacecraft into interplanetary space. The craft then comes under the influence of the sun's gravity and goes into an orbit around the sun close to earth's orbit.

The earth itself circles the sun with a speed of 18.5 miles (29.8 kilometers) per second. A spacecraft launched from earth also travels this fast in relation to the sun. The craft's escape velocity is used up in getting away from earth. It does not affect the speed of the spacecraft around the sun. Escape velocity can send the spacecraft into orbit around the sun. But it cannot send the craft to a planet.

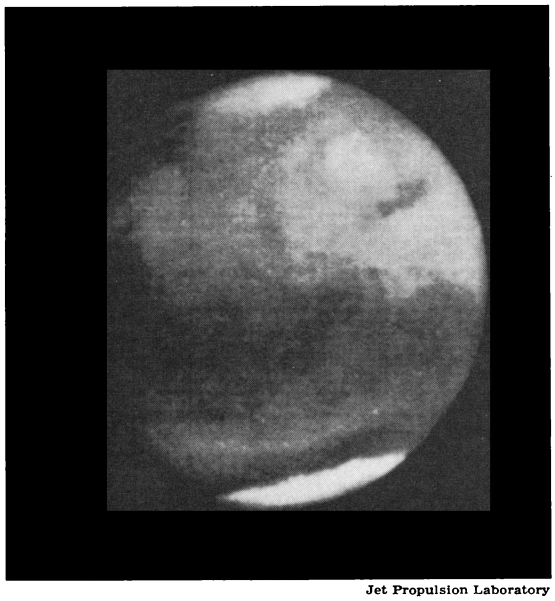
Traveling to the Planets. To reach a planet, a spacecraft must be launched from earth at a velocity greater than escape velocity. This extra velocity changes the speed of the spacecraft around the sun. Given the proper velocity, the craft goes into a solar orbit that carries it to the target planet.

To reach Mars, a spacecraft must be launched at 7.4 miles (11.9 kilometers) per second—0.4 mile (0.6 kilometer) per second faster than escape velocity. Also, the craft must be launched in the same direction the earth moves around the sun. The extra 0.4 mile per second then adds to the 18.5 miles per second the craft has because of the earth's motion. The craft's final speed around the sun is 18.9 miles (30.4 kilometers) per second. At this speed, the spacecraft coasts outward from the sun until it crosses the orbit of Mars.

To reach Venus, a spacecraft must also be launched at 7.4 miles per second. But in this case the craft is launched in a direction opposite to the direction the earth moves around the sun. The extra 0.4 mile per second is therefore subtracted from the 18.5 miles per second, giving the craft a final speed of 18.1 miles (29.1 kilometers) per second. At this speed, the spacecraft moves too slowly to stay near the orbit of earth. It is pulled closer to the sun until it crosses the orbit of Venus.

A spacecraft launched at the minimum velocity necessary to reach a planet travels along a path called a *minimum energy flight trajectory*. This is the course that requires the least power. In practice, planetary spacecraft are usually launched with a velocity greater than the minimum. With the increased speed, they can reach the planet in a shorter time.

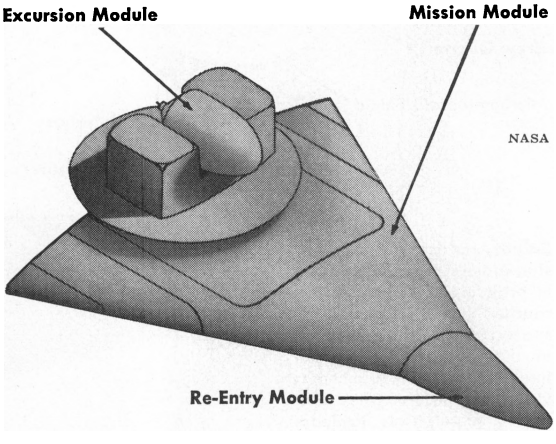
Reaching the Stars. Present rocket engines do not have enough power to send spacecraft to even the nearest star. Just to escape from the sun's gravity, a spacecraft must be launched from earth at 14.5 miles (23.3 kilometers) per second. To travel to a star in a reasonable time, the spacecraft must go at a speed close to the speed of light. In the future, such speeds may be reached by advanced rockets using nuclear power.

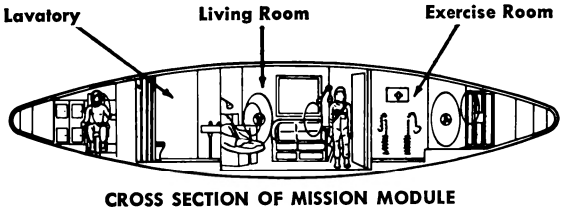


Jet Propulsion Laboratory

The Unmanned Spacecraft *Mariner VII* photographed Mars from 535,650 miles (862,045 kilometers) on Aug. 3, 1969. The south polar cap of Mars is the white area at the bottom. *Mariner VII* later traveled within 2,190 miles (3,524 kilometers) of Mars.

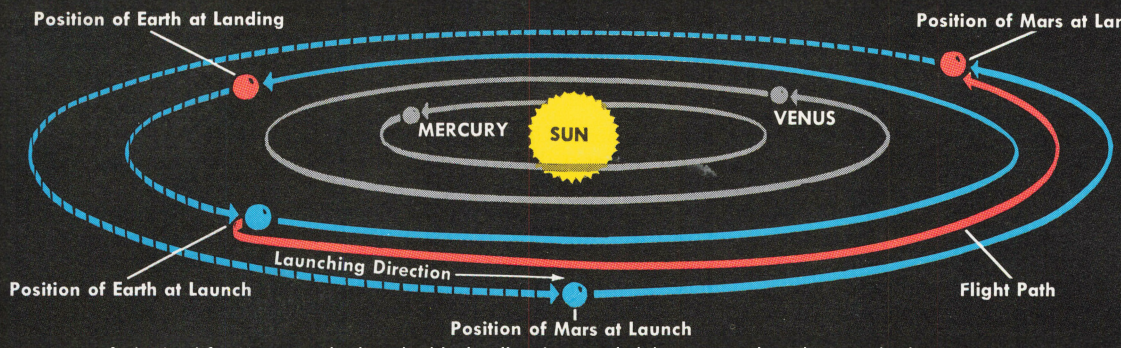
A Future Mars Spaceship, *below,* consists of three sections. The *mission module* carries six men into orbit around Mars. The men use the *excursion module* to land on Mars and to return to the orbiting mission module. They ride back to earth in the mission module and use the *re-entry module* to descend through the atmosphere.





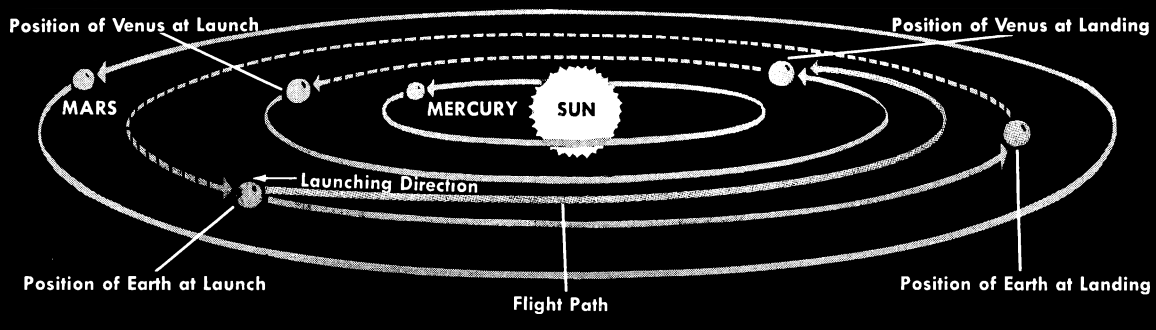
CROSS SECTION OF MISSION MODULE

A ROCKET FLIGHT TO MARS



A spacecraft destined for Mars must be launched in the direction the earth moves around the sun. The spacecraft is given a velocity slightly greater than that required to escape gravity. It slowly coasts outward from the sun until it reaches the orbit of Mars.

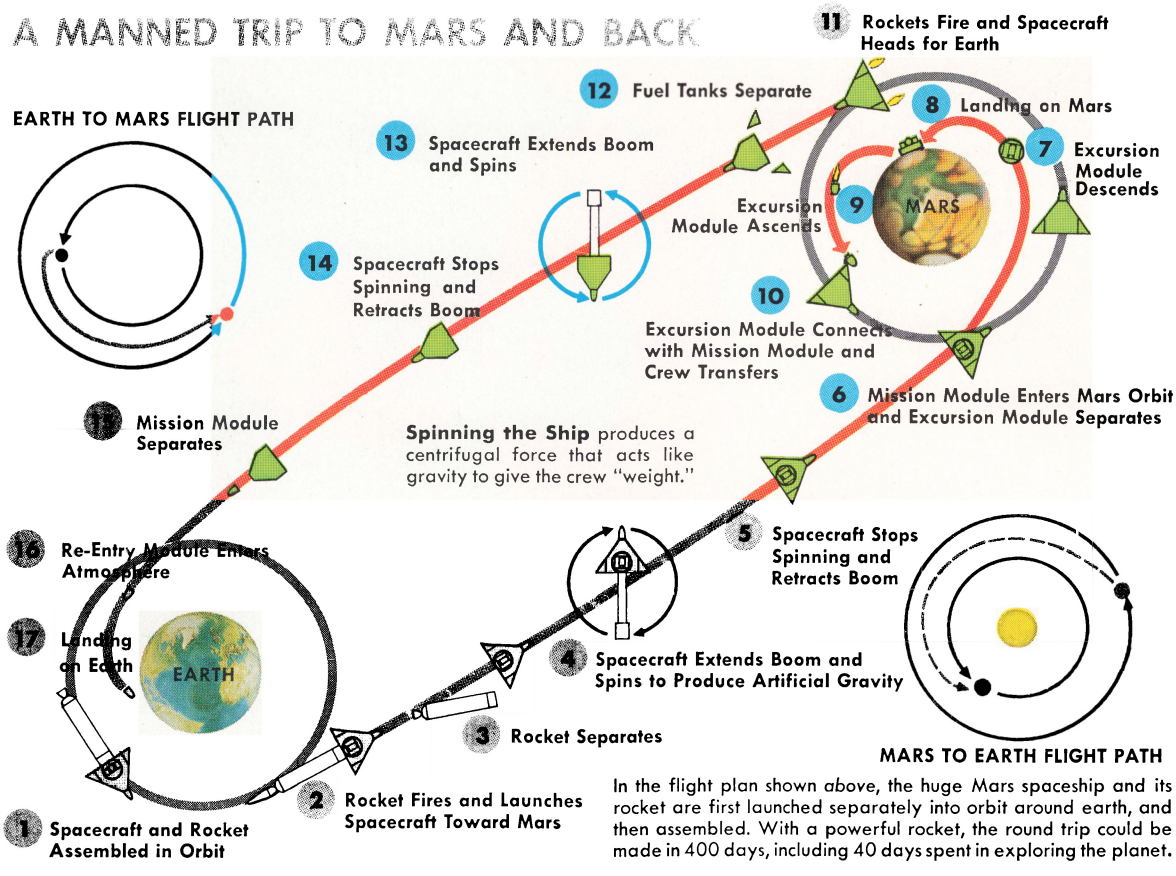
A ROCKET FLIGHT TO VENUS



A spacecraft destined for Venus must be launched in a direction opposite to that of the earth's motion around the sun. This makes the craft move too slowly to stay in the earth's orbit. The spacecraft coasts toward the sun until it reaches the orbit of Venus.

Richard Hennessy for WORLD BOOK

A MANNED TRIP TO MARS AND BACK



In the flight plan shown *above*, the huge Mars spaceship and its rocket are first launched separately into orbit around earth, and then assembled. With a powerful rocket, the round trip could be made in 400 days, including 40 days spent in exploring the planet.

Dangers in Space. The chief danger to men in space is that they depend entirely on the spacecraft that carries them. Men cannot live in space unless they have oxygen to breathe. They must also be protected from the extreme high and low temperatures and the vacuum of space. The machinery that gives them air, proper temperature, and control of the ship must operate perfectly under all conditions. In the future, pilots on long journeys may have to depend on closed *ecological systems*. These systems dispose of body wastes by using them to produce air, food, and water. They use chemical, electrical, and biological processes, including the growing of plants to produce oxygen and food.

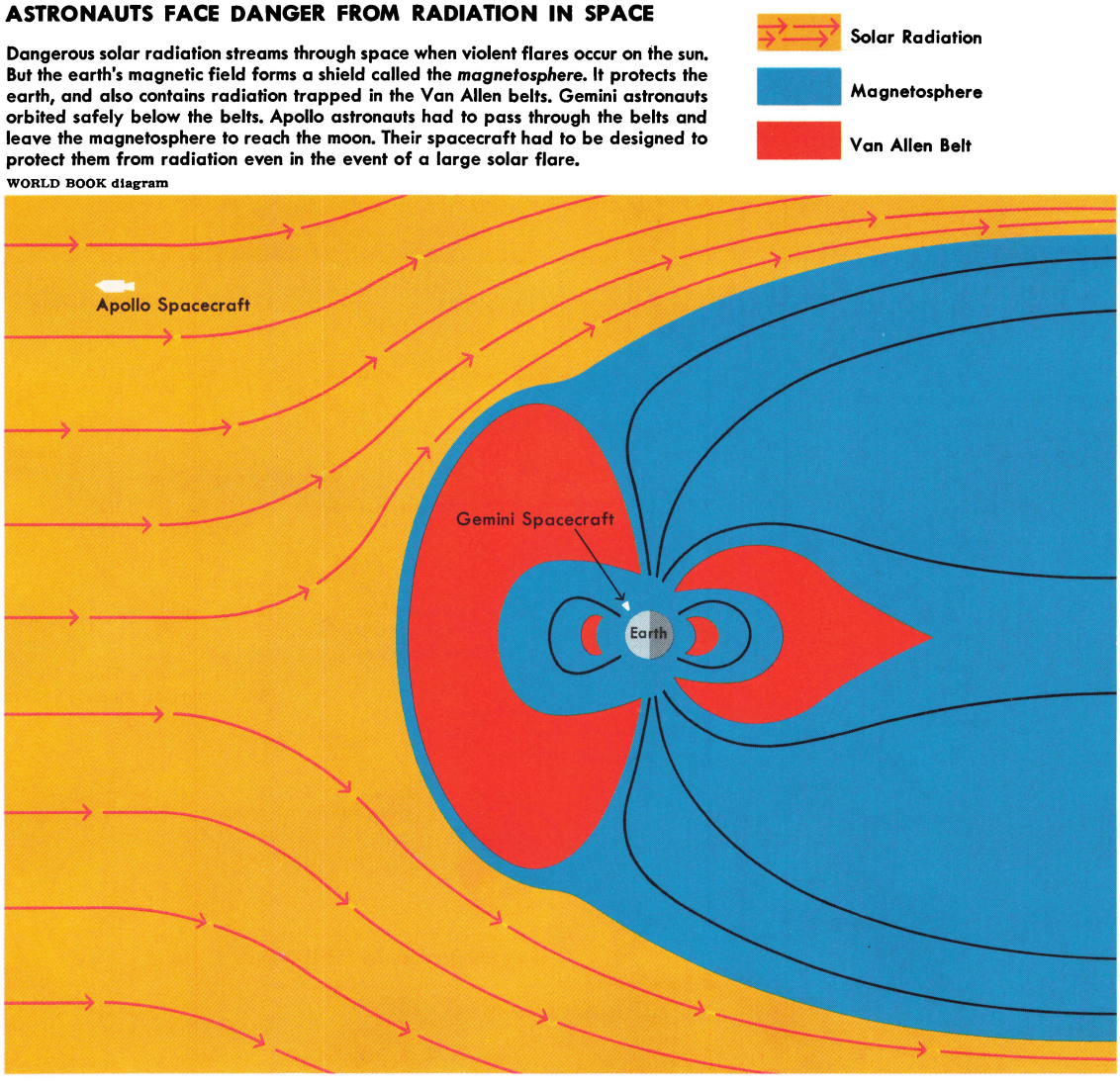
Meteoroids, even those the size of pebbles, could tear holes in a steel spacecraft. But information gathered by United States *Explorer* and *Pegasus* satellites indicates that meteoroids are not a major danger in space travel. *Pegasus II* reported an average of about one *micrometeoroid* (particle of space dust) per day hitting a "wing" 96 by 14 feet (29 by 4.3 meters) hard enough to penetrate it. A smaller spacecraft would be hit less often. The chance of a meteoroid the size of a cigarette ash hitting the Apollo spacecraft on an eight-day moon flight is about 1 in 1,230.

Radiation in space includes atomic particles such as electrons and protons, and high energy gamma rays. This radiation comes from the sun and from outside our solar system. The earth's magnetic field creates a shield in space called the *magnetosphere* that protects the earth from solar radiation. In addition, areas of radiation

ASTRONAUTS FACE DANGER FROM RADIATION IN SPACE

Dangerous solar radiation streams through space when violent flares occur on the sun. But the earth's magnetic field forms a shield called the *magnetosphere*. It protects the earth, and also contains radiation trapped in the Van Allen belts. Gemini astronauts orbited safely below the belts. Apollo astronauts had to pass through the belts and leave the magnetosphere to reach the moon. Their spacecraft had to be designed to protect them from radiation even in the event of a large solar flare.

WORLD BOOK diagram



within the magnetosphere called the Van Allen radiation belts circle the earth.

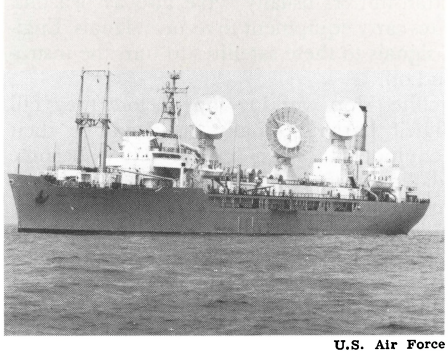
Astronauts in orbit around the earth are not usually exposed to much danger from radiation. But when they travel to the moon or other planets, they are exposed to the radiation in space. First, they travel through the Van Allen belts. After they leave the magnetosphere, they are exposed to solar radiation. Normally, this radiation is not too dangerous. But sometimes storms on the sun's surface send out dangerous amounts of radiation. Astronauts far from the earth could receive enough radiation to kill them unless their spacecraft protects them. The metal walls and heat shield provide protection. For example, Apollo astronauts receive about as much radiation in the Van Allen belts as they would from having their teeth X-rayed by a dentist. Scientists are trying to find ways to predict dangerous solar storms. Flights could then be launched when the danger of a storm was low.

Tracking a Spacecraft. The United States has a group of stations around the world to track both manned and unmanned spacecraft. Specially equipped ships track spacecraft when they are out of range of land stations. These stations receive radio signals from the spacecraft. The signals may carry astronauts' voices, information about the spacecraft's operation, or television pictures from space. The controllers of manned flights use radio transmitters at the tracking stations to talk to the astronauts. The stations also send tracking information about the spacecraft to a computer in the Goddard Space Flight Center in Greenbelt, Md. The computer calculates the position and orbit of the spacecraft.

Different tracking networks are needed to follow various kinds of space flights. For example, the orbital space flight network tracks manned flights that orbit the earth. When spacecraft leave earth orbit on a flight to the moon, the deep space network takes over the tracking and communications job. Another network of stations tracks unmanned satellites.

Space Medicine is the study of how space flight affects man's body and his ability to work. Space medicine grew from aviation medicine, and it uses many of the same testing methods. The astronaut himself is the main source of information. He carries special devices that measure his heart beat, breath rate, and the amount of radiation he has received. Medical specialists study him carefully before, during, and after a space flight to learn the body's strength and weakness in space. They can then suggest ways of giving astronauts better protection.

Doctors have learned that an astronaut can withstand the forces that act on his body during the launching and the return to earth. He can eat, sleep, and work while his body is weightless during flight. But the astronaut's legs and ankles may swell slightly if he stays in one position too long without exercise. Some astronauts have developed minor illness in flight, and doctors on earth have prescribed medicine for them. Each spacecraft carries a medical kit.

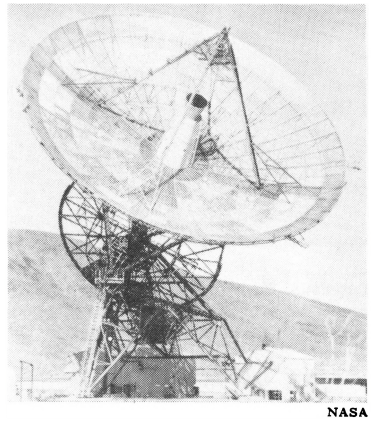


U.S. Air Force

Tracking Ships, *left,* **maintain contact with spacecraft over the ocean beyond the range of land stations.**

Tracking Antennas, *right,* **point at the spacecraft and follow it across the sky as long as it flies above the horizon.**

Worldwide Networks of U.S. tracking stations, *below,* **send flight information to a central computer in Greenbelt, Md.**



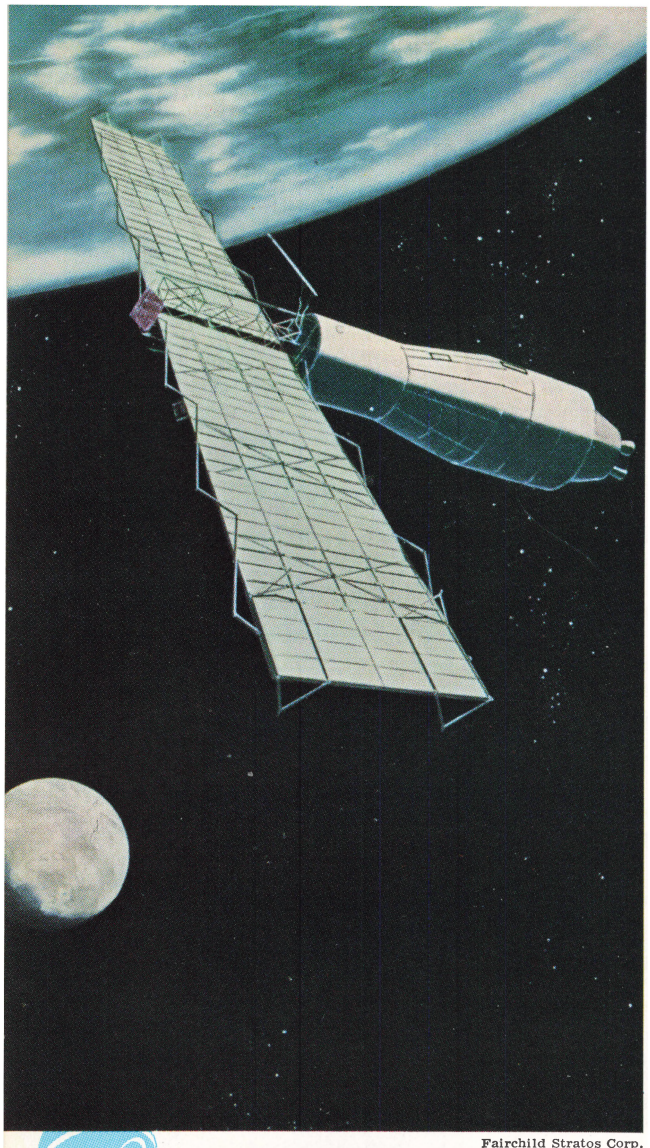
NASA

MANNED SPACE FLIGHT TRACKING STATIONS

Stations Tracking Orbital Space Flights

Stations Tracking Deep Space Flights

SPACE TRAVEL / ARTIFICIAL SATELLITES



Fairchild Stratos Corp.

Pegasus Meteoroid Detection Satellite, *above,* has a "wing" 96 feet (29 meters) long. As meteoroids pierce the wing, instruments record the hits and send the information to the earth.

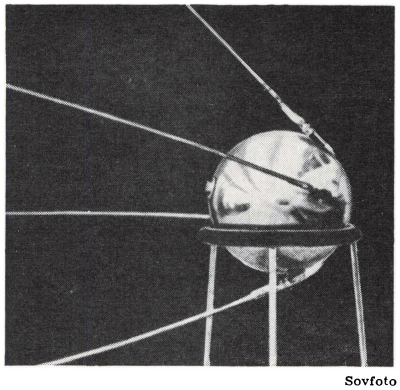
An artificial satellite is a man-made "moon." It circles the earth in space along a path called an *orbit.* An artificial satellite may be designed in almost any shape, such as a ball, a drum, or a box. It does not have to be streamlined, because there is little or no air where it travels in space. A satellite's size and shape depend on its job. Some satellites, such as the *Echo* balloons, may be 100 feet (30 meters) or more in diameter. But most satellites are much smaller.

Artificial satellites stay in space for varying lengths of time. The lifetime of each satellite depends on its size and its distance from earth. Whenever a satellite swings close to earth, it runs into many air particles that slow it down. To stay in orbit, a satellite must keep a certain speed. If it slows below this speed, it plunges into the atmosphere and burns up because of friction with the air. The slowing of a satellite by air particles is called *decay.* Large satellites in low orbits decay rapidly. Small ones in high orbits decay slowly. For example, the 6-inch (15-centimeter) *Vanguard I* satellite orbits more than 400 miles (640 kilometers) above the earth. It will orbit for hundreds of years.

Every satellite carries some kind of radio transmitter. One kind of transmitter is called a *radio beacon.* It sends signals that enable engineers to track the satellite. *Tracking* means finding the satellite's exact position in space. Another kind of transmitter sends to earth the scientific information gathered by the satellite's instruments. This sending of information is called *telemetry.* Telemetry transmitters usually serve also as beacons. Some satellites carry equipment to receive signals. Engineers beam signals to these satellites to turn the instruments on and off.

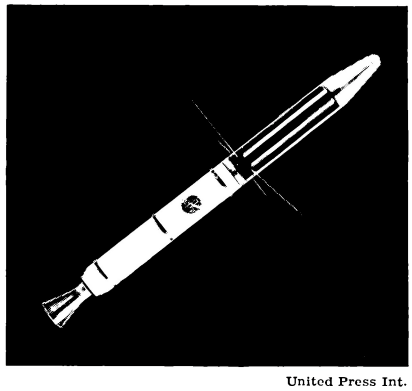
Most satellites stop working long before they fall to earth. Their batteries finally go dead, or their electronic equipment breaks down. They become "silent" and of no further use. Dozens of silent satellites are now circling the earth.

Artificial satellites may be classified according to the jobs they do as (1) weather satellites, (2) communications satellites, (3) navigation satellites, (4) scientific satellites, and (5) military satellites.



Sovfoto

Sputnik I, the first artificial earth satellite, was launched by Russia on Oct. 4, 1957. Its launch marked the start of the Space Age.



United Press Int.

Explorer I, the first U.S. satellite, went into orbit on Jan. 31, 1958, and discovered Van Allen radiation surrounding the earth.

IMPORTANT SATELLITES

Communications Satellites

Date Launched	Name	Accomplishments
1958 Dec. 18	**Project Score**	Broadcast first voice message from space.
1960 Aug. 12	**Echo I**	First passive communications satellite.
Oct. 4	**Courier**	First active communications satellite.
1962 July 10	**Telstar I**	First satellite to relay television programs between United States and Europe.
1963 July 26	**Syncom II**	First synchronous satellite.
1964 Jan. 25	**Echo II**	Used in joint Russian-U.S. experiments.
Aug. 19	**Syncom III**	Relayed telecasts of Olympic Games from Tokyo to the United States.
1965 Apr. 6	**Early Bird**	First commercial communications satellite; linked Europe and United States.
Apr. 23	**Molniya I**	First Russian communications satellite.
1967 Jan. 11	**Intelsat IIB**	First of a series of satellites in stationary orbit; used for television, data, or voice.
1969 Feb. 9	**Tacsat I**	Relayed communications between small ground stations for the military.
1971 Jan. 26	**Intelsat IVA**	First high-capacity international communications satellite.
1974 May 30	**ATS-6**	Brought two-way voice and picture communication to isolated areas.

Weather Satellites

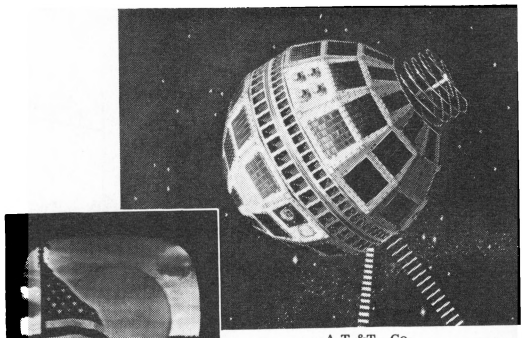
Date Launched	Name	Accomplishments
1959 Feb. 17	**Vanguard II**	First satellite to send weather information back to earth.
1960 Apr. 1	**Tiros I**	Took the first detailed weather pictures.
Nov. 23	**Tiros II**	Took weather pictures and measured infrared rays given off by earth.
1962 Sept. 18	**Tiros VI**	Photographed weather over flight path of astronaut Walter Schirra.
1963 Dec. 21	**Tiros VIII**	Carried special camera system that transmitted cloud pictures automatically.
1966 Feb. 3	**ESSA I**	First nonexperimental weather satellite; part of a worldwide weather system.
1969 Apr. 14	**Nimbus III**	Measured temperature, water vapor content, and ozone in earth's atmosphere.
1974 May 17	**SMS-1**	First full-time weather satellite in synchronous orbit.

Navigation Satellites

Date Launched	Name	Accomplishments
1960 Apr. 13	**Transit IB**	First navigation satellite.
June 22	**Transit IIA**	Carried Canadian-built instruments to measure radio interference in space.
1961 Feb. 21	**Transit IIIB**	First satellite to broadcast precise information on its own position.
June 29	**Transit IVA**	First satellite to use nuclear power.
Nov. 15	**Transit IVB**	Tested method of using earth's gravity to keep satellites in proper position.
1972 Sept. 2	**Triad OI-1**	First navigation satellite to follow an orbit that keeps it over one point on earth.

Scientific Satellites

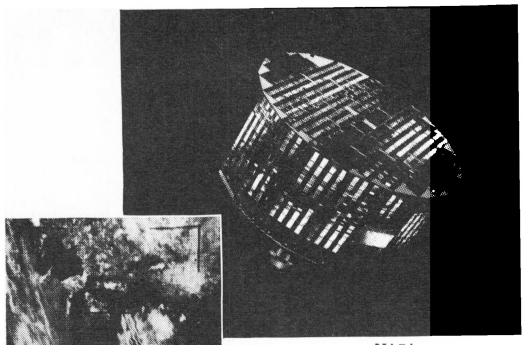
Date Launched	Name	Accomplishments
1958 Jan. 31	**Explorer I**	First U.S. satellite; discovered Van Allen radiation in space.
Mar. 17	**Vanguard I**	Discovered that earth is pear-shaped.
1959 Aug. 7	**Explorer VI**	Mapped Van Allen radiation.
1961 Aug. 16	**Explorer XII**	Explored space from 180 to 47,800 miles (290 to 76,930 kilometers) from earth.
1962 Mar. 7	**OSO-I**	First orbiting solar observatory.
Apr. 26	**Ariel (U.K. No. 1)**	First international satellite; carried U.S. and British instruments.
Sept. 28	**Alouette**	First Canadian satellite.
1963 Apr. 2	**Explorer XVII**	First satellite to study the atmosphere.
1964 Sept. 4	**OGO-I**	First orbiting geophysical observatory.
1965 Feb. 16	**Pegasus I**	Measured meteoroid density in space.
Apr. 3	**Snap 10A**	Carried nuclear-powered rocket motor.
1966 Feb. 22	**Cosmos 110**	Orbited 2 dogs for 22 days; cared for their biological needs automatically.
1967 Sept. 7	**Biosatellite II**	Carried living cells, plants, and animals into space and returned them to earth.
1968 Dec. 7	**OAO-II**	First successful orbiting astronomical observatory.
1972 July 23	**LandSat-1**	Photographed the earth with different wavelengths of light to provide information about earth's natural resources.



A.T.&T. Co.

Telstar

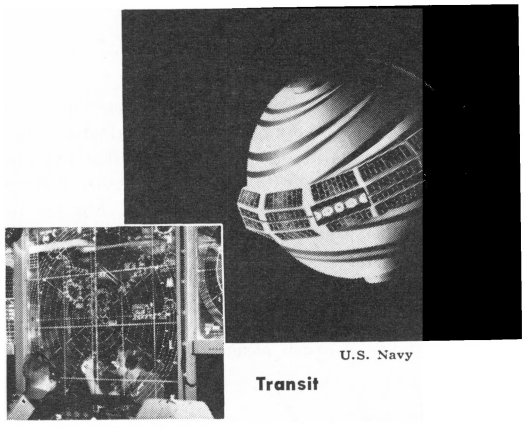
Wide World



NASA

Tiros

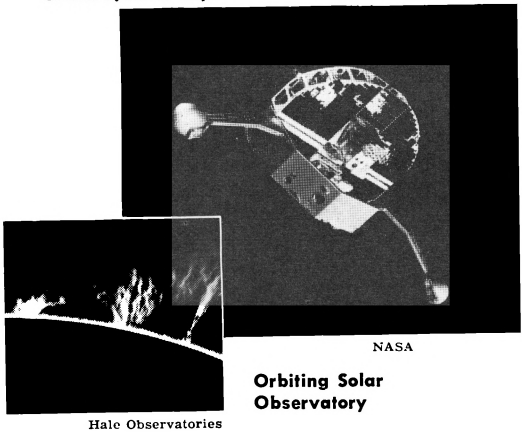
Wide World



U.S. Navy

Transit

General Dynamics Corp.

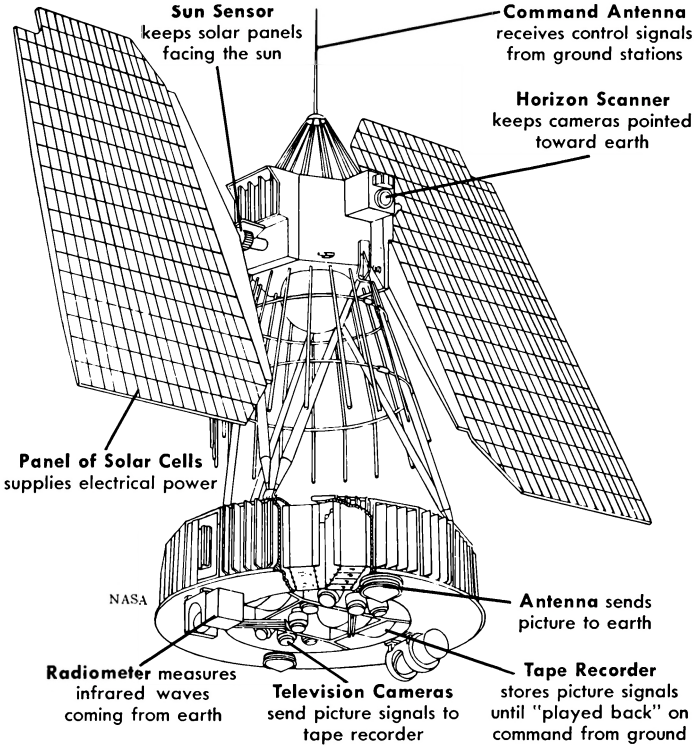


NASA

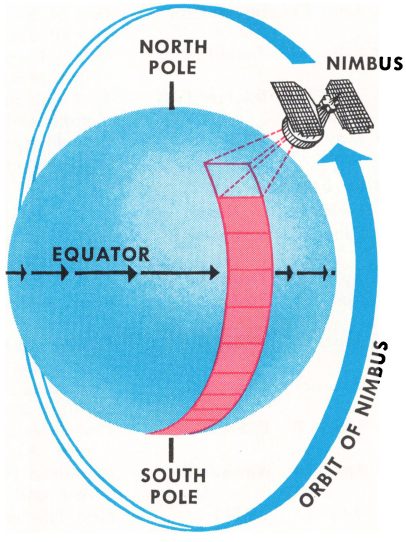
Orbiting Solar Observatory

Hale Observatories

The Nimbus Weather Satellite



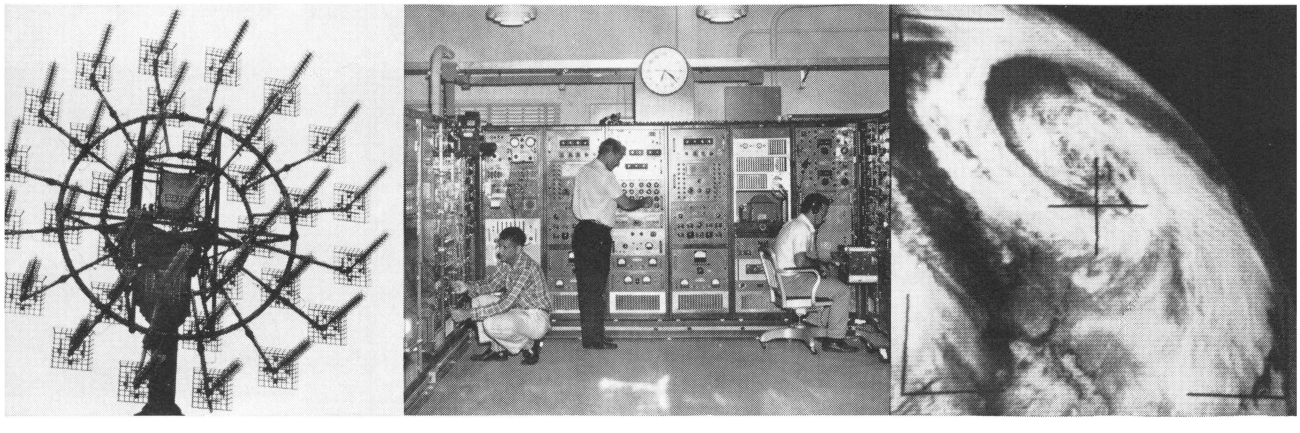
Nimbus watches the weather from a height of more than 500 miles (800 kilometers). As shown *below*, the satellite orbits in a north-south direction and takes a band of pictures during each orbit. But as the earth rotates, each orbit carries Nimbus over a different strip of the earth's surface. In this way, the satellite photographs the entire earth once every day.



Weather Satellites, or *meteorological satellites*, help scientists forecast weather and study how weather is made. The first satellites to do this job were called *Tiros*. These satellites carry television cameras that take pictures of the earth's surface. The pictures show how clouds move through the atmosphere. They also show snow and ice on the earth's surface. By studying the pictures, weathermen can discover dangerous storms forming over the ocean. They can then warn people to prepare for the storms.

Weather satellites also carry instruments called *infrared detectors*. These instruments measure the heat

Receiving Weather Pictures from Space requires special equipment, *below*. As the weather satellite passes over a ground station, it beams picture signals and other information down to sensitive antennas, *left*. The signals are sorted out and strengthened by electronic equipment in a "readout room," *center*, and sent to a facsimile recorder that makes the cloud photograph, *right*. NASA



coming from the earth and the clouds. This information helps scientists learn how weather is related to the heating and cooling of the earth.

A Tiros satellite "sees" the earth only part of the time because it always points to a certain spot in space. An advanced weather satellite called *Nimbus* points its camera toward earth all the time.

Communications Satellites make it possible to send radio messages, telephone calls, and television programs between distant parts of earth. Communications satellites are called *passive* or *active*, depending on the way they work.

The *Echo* balloon is an example of a passive communications satellite. It acts as a mirror for radio waves. A sending station on earth beams waves to the satellite. The waves "bounce" off the satellite and return to earth. They then reach a receiving station perhaps thousands of miles from the sending station.

Telstar, *Relay*, *Syncom*, and *Early Bird* are active communications satellites. They carry radio receivers and transmitters. Active satellites receive signals from sending stations, *amplify* (strengthen) them, and send them back to earth. See COMMUNICATIONS SATELLITE.

Navigation Satellites help pilots and sailors find their exact positions in all kinds of weather. The United States Navy's navigation satellite is called *Transit*. Navigators can use it to find their position much as they would use a star. But instead of looking at the satellite, they listen to its radio signals.

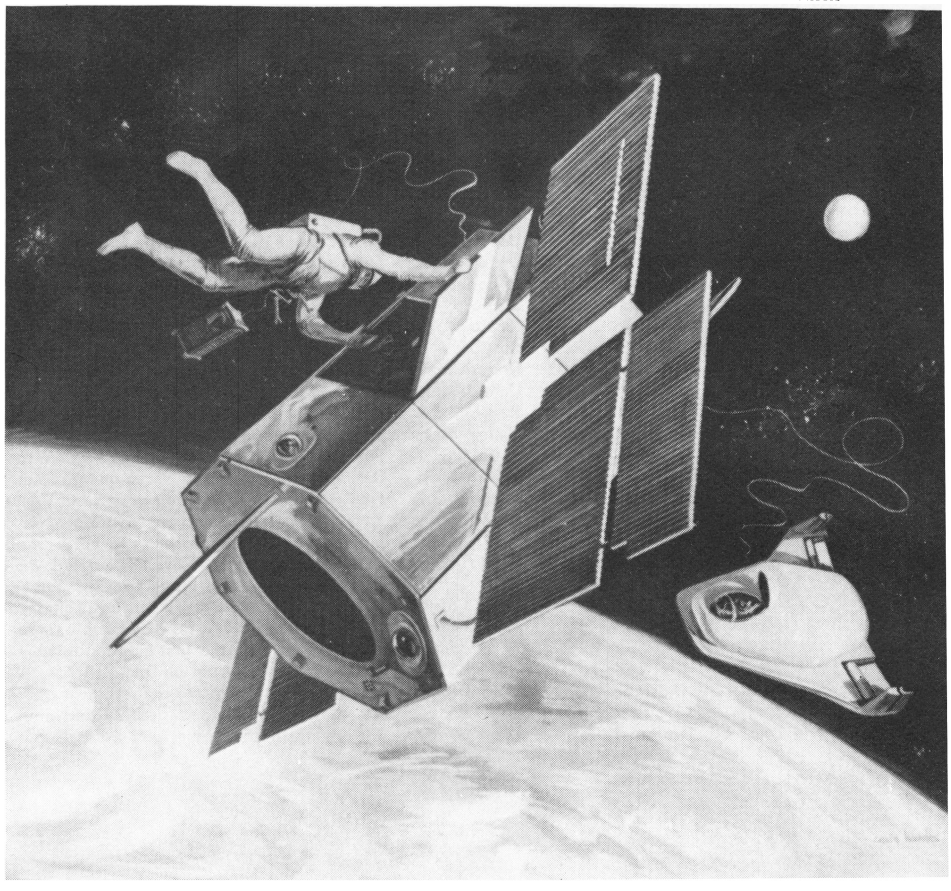
Scientific Satellites include several types. *Explorer* and *Monitor* satellites carry a variety of instruments around earth. Some instruments measure radiation, such as that found in the Van Allen belt. Other instruments called *magnetometers* measure the earth's magnetic field. Satellites called *topside sounders* explore the upper parts of the atmosphere. These satellites beam radio waves down into the atmosphere and then measure the reflected signals.

Orbiting observatories are the largest and most complicated of all scientific satellites. The United States uses three types—geophysical, solar, and astronomical. Each type has a standard size and shape. Many kinds of instruments can be built into each one. The *orbiting geophysical observatory* (OGO) explores space near the earth. Scientists use it to study how the earth's magnetic field affects energy coming from the sun. The sun itself is studied with the *orbiting solar observatory* (OSO). This satellite measures radiations that cannot get through the atmosphere to be measured on earth. The *orbiting astronomical observatory* (OAO) looks deep into space at the stars and galaxies. It too measures rays that never reach the earth.

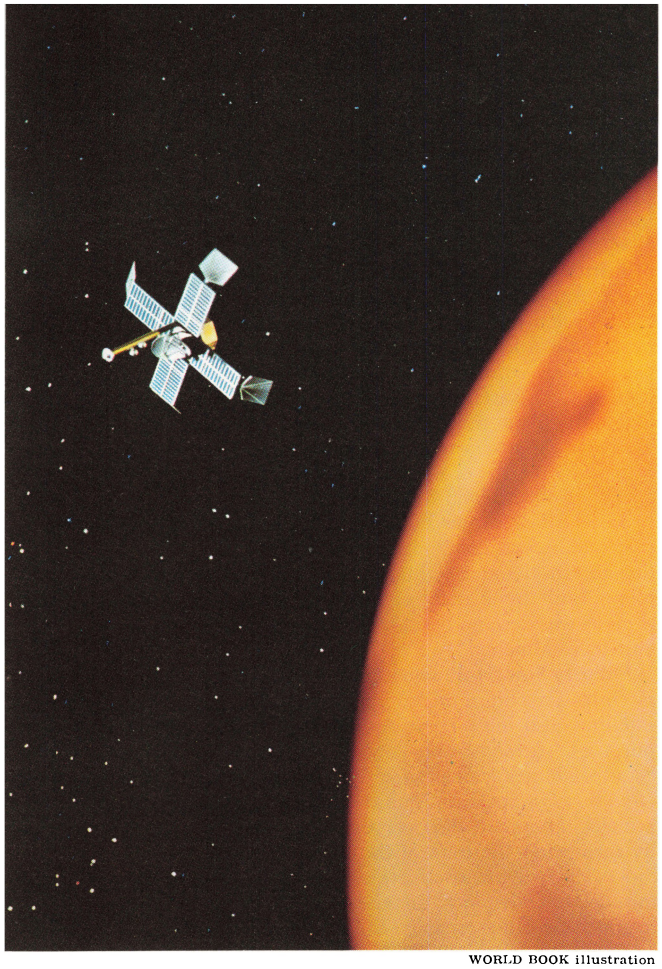
The United States builds and launches some scientific satellites in cooperation with other countries. The first international satellite, called *Ariel*, carried instruments built by British scientists. The topside sounder *Alouette* was designed and built by Canadian engineers, and then launched by the United States.

Military Satellites. The armed forces can use artificial satellites for communications and for navigation. But satellites also have been designed for strictly military purposes. *Reconnaissance satellites*, sometimes called "spy" satellites, can photograph enemy ground forces. *Warning satellites* can guard against surprise missile attacks. They can discover the launching of a missile by measuring the heat of the missile's rocket exhaust. Since 1963, the United States has kept *Vela* satellites in space to detect any "sneak testing" of nuclear bombs in space by other nations. Many military space activities are kept secret.

NASA



Satellite Repairmen of the future may fix damaged satellites as they orbit the earth in space. A repairman would ride into orbit in a small spaceship, "park" near the satellite, and then use a small rocket belt to travel to the satellite.



WORLD BOOK illustration

***Mariner IV* Flew Past Mars In 1965.**

SPACE TRAVEL / SPACE PROBES

Space probes are used to explore space at various distances from earth. Four main kinds of probes are: (1) sounding rockets, (2) lunar spacecraft, (3) interplanetary probes, and (4) planetary probes.

Sounding Rockets carry instruments into the upper atmosphere and into space near earth. They are the chief means of exploring regions too close for satellites to orbit. Their instruments may measure the temperature and pressure of the atmosphere as well as radiations from space.

Lunar Spacecraft explored the moon to prepare the way for man to land there. United States lunar spacecraft include *Ranger*, *Surveyor*, and *Lunar Orbiter*. In 1964 and 1965, three Rangers sent more than 17,000 close-up pictures of the moon back to the earth before crashing into the moon. The first Surveyor spacecraft landed on the moon in 1966 and sent back pictures of the lunar landscape. The first Lunar Orbiter orbited the moon in 1966. Scientists learned from the Lunar Orbiters that the moon's gravitational field is irregular.

Russian lunar spacecraft include *Luna* and *Zond*. The moon's hidden side was photographed by *Luna 3* in 1959 and by *Zond 3* in 1965. In 1966, *Luna 9* landed on the moon and sent back pictures of the surface. *Zond 5* orbited the moon and returned to earth in 1968.

Interplanetary Probes explore space between the planets. They do not reach a specific body in space.

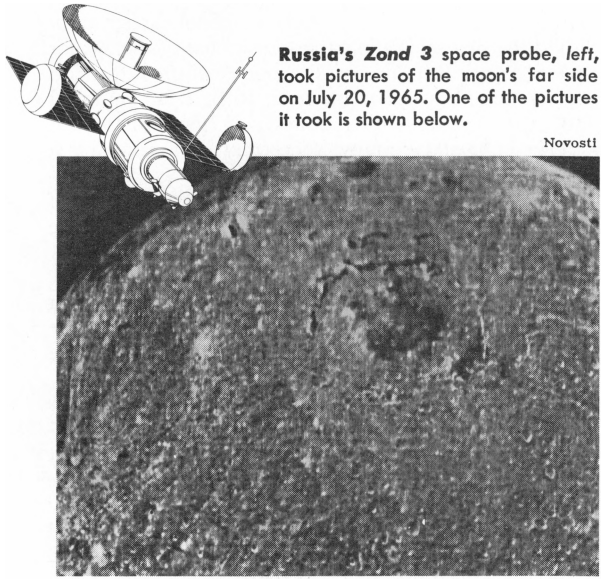
Planetary Probes were sent to the nearby planets Venus and Mars during the 1960's. In the 1970's, probes were also sent to more distant planets. Planetary

IMPORTANT SPACE PROBES

Date Launched	Name	Country	Accomplishments
1959 Jan. 2	**Luna 1**	Russia	Lunar probe; missed moon and became the first spacecraft to orbit the sun.
Mar. 3	**Pioneer IV**	United States	Lunar probe; missed moon and became the first U.S. probe to orbit the sun.
Sept. 12	**Luna 2**	Russia	First probe to strike the moon.
Oct. 4	**Luna 3**	Russia	Photographed the hidden side of the moon on Oct. 7, 1959.
1960 Mar. 11	**Pioneer V**	United States	Transmitted data from 22,000,000 miles (35,400,000 kilometers) in space.
1962 Apr. 23	**Ranger IV**	United States	First U.S. probe to strike moon; failed to televise pictures to earth.
Aug. 27	**Mariner II**	United States	Passed near Venus on Dec. 14, 1962; sent scientific information to earth.
1964 July 28	**Ranger VII**	United States	Televised 4,308 pictures of moon to the earth on July 31, 1964.
Nov. 28	**Mariner IV**	United States	Photographed Mars on July 14, 1965; measured conditions in space.
1965 Nov. 16	**Venera 3**	Russia	First spacecraft to hit Venus; crashed on March 1, 1966.
1966 Jan. 31	**Luna 9**	Russia	Made first soft landing on the moon on Feb. 3; sent 27 pictures to the earth.
Mar. 31	**Luna 10**	Russia	First spacecraft to orbit the moon; began orbiting on April 3.
May 30	**Surveyor 1**	United States	Landed on the moon June 2; sent 11,237 pictures to the earth.
Aug. 10	**Lunar Orbiter I**	United States	Began orbiting the moon on Aug. 14. Photographed future landing sites.
1967 June 12	**Venera 4**	Russia	First spacecraft to transmit data on Venus' atmosphere.
Sept. 8	**Surveyor 5**	United States	Landed on the moon; sent information on lunar soil back to earth for analysis.
1968 Sept. 14	**Zond 5**	Russia	First probe to orbit the moon and return to a soft landing on earth.
1969 Mar. 27	**Mariner VII**	United States	Returned high-quality pictures of Mars' south polar cap.
1970 Aug. 17	**Venera 7**	Russia	First spacecraft to transmit data from Venus' surface; landed Dec. 15, 1970.
Sept. 12	**Luna 16**	Russia	First unmanned spacecraft to bring lunar samples to earth. Landed on the moon Sept. 20, began return to earth Sept. 21, landed Sept. 24.
Nov. 10	**Luna 17**	Russia	Landed on the moon Nov. 17; carried vehicle that explored lunar surface.
1971 May 28	**Mars 3**	Russia	Carried capsule that made first soft landing on Mars; landed Dec. 2, 1971.
May 30	**Mariner IX**	United States	First probe to orbit Mars; began orbiting on Nov. 13, 1971.
1972 Mar. 2	**Pioneer X**	United States	First probe to Jupiter; flew by the planet on Dec. 3, 1973, and sent back scientific data; will be the first man-made object to leave the solar system.
1973 April 6	**Pioneer XI**	United States	Passed close to Jupiter on Dec. 2, 1974; sent back pictures and scientific data.
Nov. 3	**Mariner X**	United States	First probe to fly by two planets; sent photos and data from Venus on Feb. 5, 1974, and Mercury on March 29 and Sept. 21, 1974, and March 16, 1975.
1974 Dec. 10	**Helios 1**	West Germany	Closest approach to sun; sent back data.

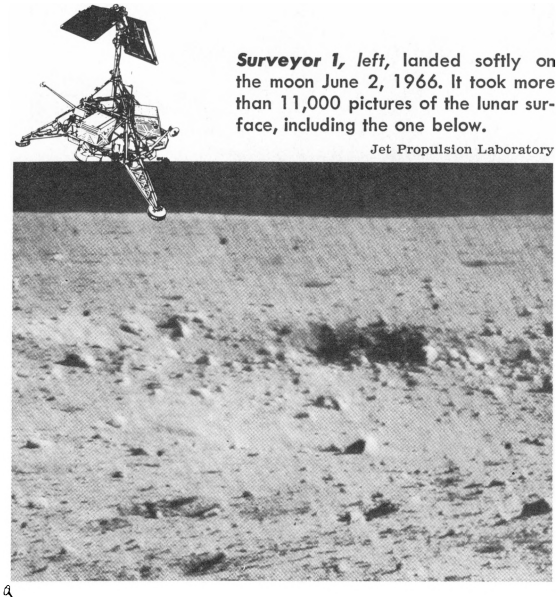
probes travel in orbits around the sun. They either fly past the target planet or go into orbit around it. Even at a great distance, a probe's instruments can collect much information about the planet. In 1962, the United States *Mariner II* passed within 22,000 miles (35,400 kilometers) of Venus. It reported that the planet's temperature is about 800° F. (430° C)—too hot for any known animal or plant. In 1965, *Mariner IV* flew as close as 6,118 miles (9,846 kilometers) to Mars. The spacecraft reported Mars has a thin atmosphere, no magnetic field, and no radiation belt. In 1966, the Russian spacecraft *Venera 3* crashed on Venus. In 1967, Russia's *Venera 4* transmitted information on Venus' atmosphere before crashing into the planet. In 1971, the *Mariner IX* probe orbited Mars and provided photographs of most of its surface as well as of its two moons. Also that year, the Russian *Mars 3* spacecraft orbited the planet and soft-landed a capsule.

The United States *Pioneer X* became the first probe to reach Jupiter. In 1973, it sent back data about Jupiter's radiation belt and atmosphere. In 1974, *Mariner X* became the first probe to fly past two planets. It returned photographs and data from Venus and Mercury. Also in 1974, the United States *Pioneer-Saturn* probe photographed Jupiter's vast polar regions. After circling Jupiter, it sped toward Saturn, which it will orbit. A United States *Viking* craft was launched in 1975 to return data on Mars. It is scheduled to land on Mars in 1976, and may enable scientists to determine whether any form of life exists on the planet.



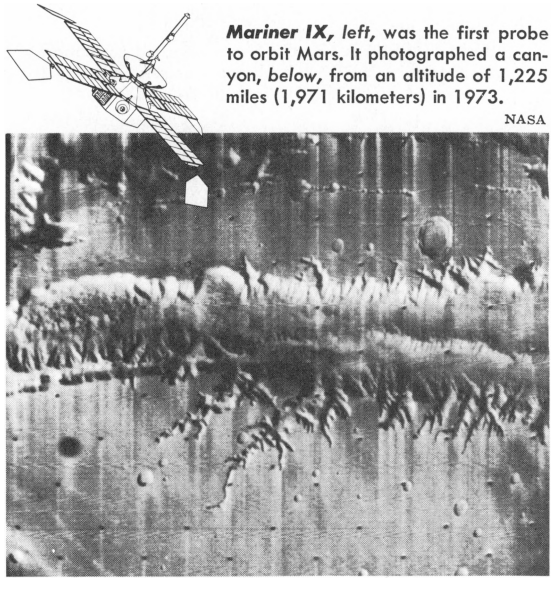
Russia's *Zond 3* space probe, *left*, took pictures of the moon's far side on July 20, 1965. One of the pictures it took is shown below.

Novosti



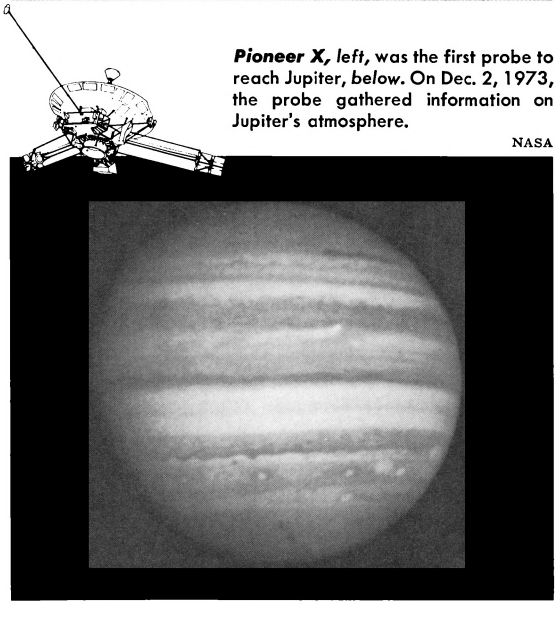
Surveyor 1, *left*, landed softly on the moon June 2, 1966. It took more than 11,000 pictures of the lunar surface, including the one below.

Jet Propulsion Laboratory



Mariner IX, *left*, was the first probe to orbit Mars. It photographed a canyon, *below*, from an altitude of 1,225 miles (1,971 kilometers) in 1973.

NASA



Pioneer X, *left*, was the first probe to reach Jupiter, *below*. On Dec. 2, 1973, the probe gathered information on Jupiter's atmosphere.

NASA

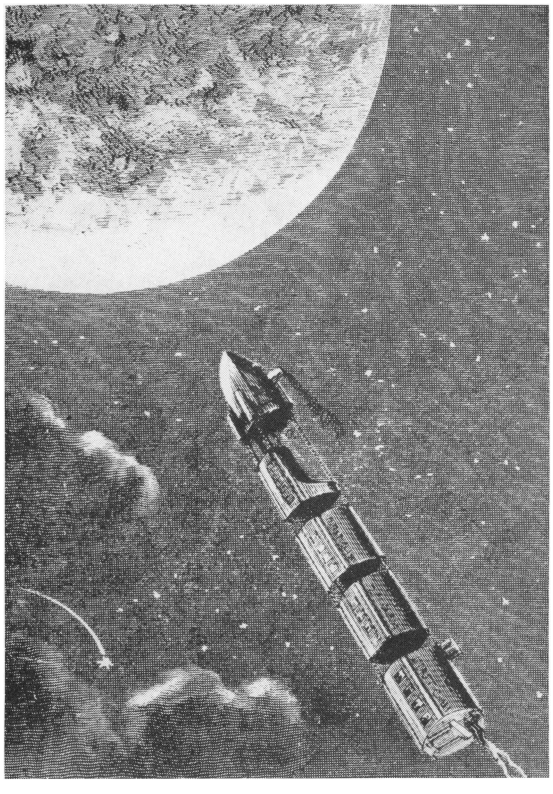
SPACE TRAVEL

STEPS IN THE CONQUEST OF SPACE

New York Public Library

Man's Dream of Space Travel has led him to design strange spaceships. About 1780, a Frenchman thought a spaceship, *above*, might use a balloon, a parachute, and movable wings. In 1865, the French novelist Jules Verne described a "moon train," *below*.

Bettmann Archive



The history of space travel could be said to begin more than 300 years ago. In the early 1600's, Johannes Kepler, a German scientist, developed the laws of planetary motion that describe the orbits of bodies in space. Today, these laws are used to determine the orbits of artificial satellites and to plan the flights of spacecraft. See KEPLER, JOHANNES.

In 1687, Sir Isaac Newton published his *Laws of Motion*, which used Kepler's work as a base. Newton's laws, like Kepler's, form a cornerstone of space-flight planning. For example, his third law states that for every action there is an equal and opposite reaction. This law describes why a rocket works. See MOTION (Newton's Laws of Motion); NEWTON, SIR ISAAC.

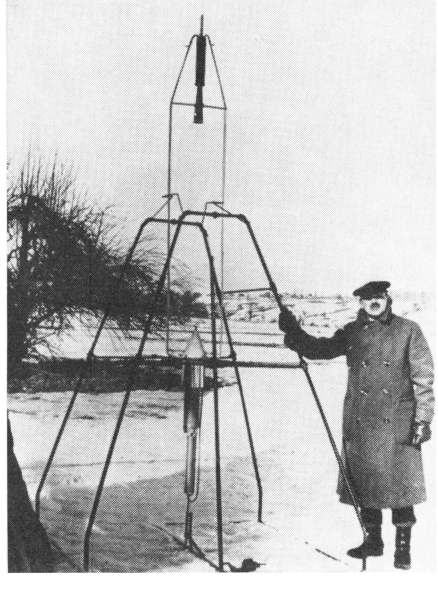
Early Developments. In 1903, Konstantin E. Tsiolkovsky (1857-1935), a Russian schoolteacher, published the first scientific paper on the use of rockets for space flight. But his work attracted little attention at the time. Several years later, Robert H. Goddard (1882-1945), of the United States, and Hermann Oberth (1894-), of Germany, succeeded in awakening a scientific interest in space travel. Working independently, these men attacked the technical problems of rocketry and high-altitude research. They earned the title "the fathers of space flight."

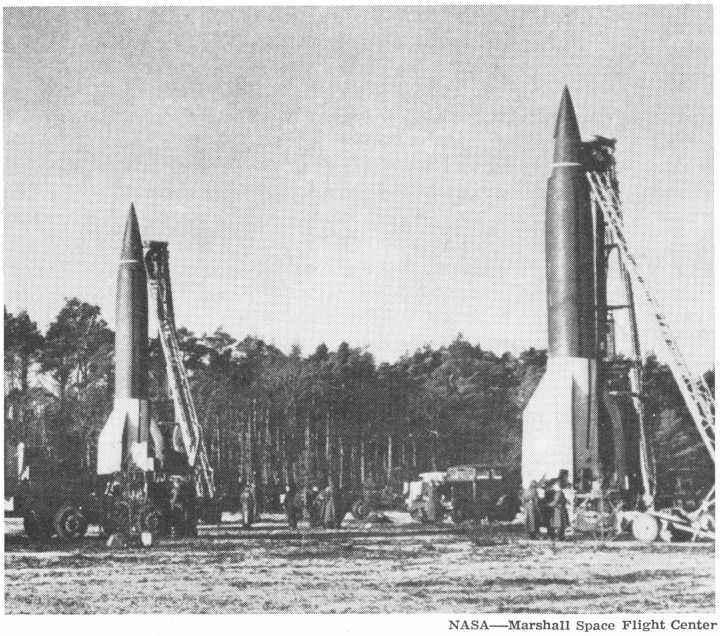
In 1919, Goddard explained how rockets could be used to explore the upper atmosphere in his paper "A Method of Reaching Extreme Altitudes." The paper also described a way of firing a rocket to the moon. See GODDARD, ROBERT H.

Oberth published *The Rocket into Interplanetary Space* in 1923. In this book, Oberth discussed many technical problems of space flight. He even described what a spaceship would be like. Interest in Oberth's work in Germany led to the formation of the German Society for Space Travel. The members of this society helped develop the first successful guided missiles during World War II. See GUIDED MISSILE (The First Guided Missiles).

First Liquid-Fuel Rocket was launched by Robert H. Goddard in 1926. It burned gasoline and liquid oxygen and traveled 184 feet (56 meters).

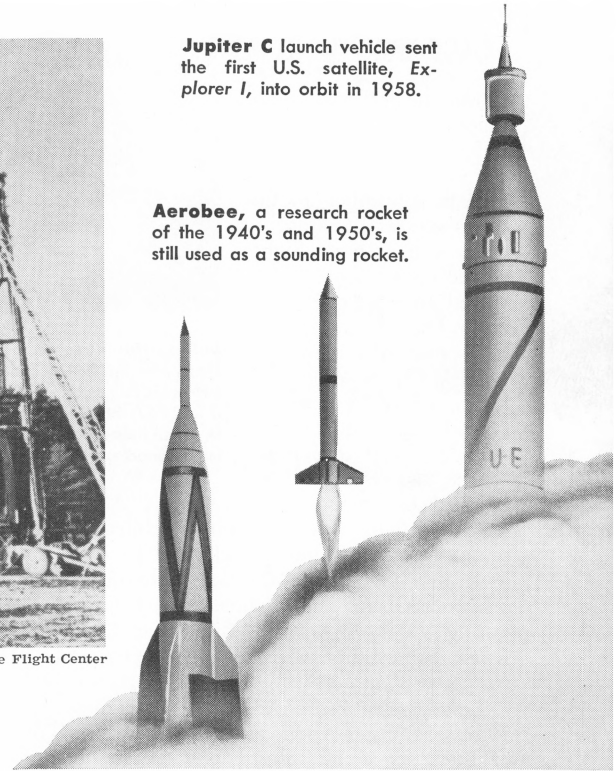
United Press Int.





NASA—Marshall Space Flight Center

A Captured German V-2, like those shown *above,* was used to launch a U.S. *WAC Corporal* rocket to a height of 250 miles (402 kilometers) in 1949. The *WAC Corporal* looked like a spike at the top of the V-2, *right.*



Jupiter C launch vehicle sent the first U.S. satellite, *Explorer I,* into orbit in 1958.

Aerobee, a research rocket of the 1940's and 1950's, is still used as a sounding rocket.

In the United States, experimenters formed the American Interplanetary Society in 1930. British scientists founded the British Interplanetary Society in 1933. Members of these groups designed and launched experimental rockets, and promoted the idea of space travel.

High-Altitude Rockets. During the 1930's, rocket research went forward in the United States, Germany, and Russia. Goddard was the chief American researcher, while Oberth led the German experimenters. Leading Russian scientists included F. A. Tsander (1887-1933) and I. A. Merkulov (1913-). By the early 1930's, both the German and Russian governments were conducting rocket research programs. The United States government did not become interested in high-altitude rockets until the early 1940's.

During World War II, German rocketeers under the direction of Wernher von Braun (1912-) developed the powerful *V-2* guided missile. A number of these missiles were captured by American forces and sent to the United States to be used in research. After the war, Von Braun and some of the other German scientists came to the United States to continue their work on rockets. Others went to Russia.

In the late 1940's, Americans developed two important research rockets, the *Viking* and the *Aerobee.* In 1949, a small rocket called the *WAC Corporal* soared to what was then a record height of 250 miles (402 kilometers). It was launched as a second stage atop a V-2 missile.

Man-Made Moons. In 1955, both the United States and Russia announced plans to launch artificial satellites. The "moons" were to be launched during the International Geophysical Year beginning in 1957.

Then, on Oct. 4, 1957, the Russians launched *Sputnik I,* man's first artificial satellite. On Nov. 3, 1957, they launched a second satellite, *Sputnik II.* It carried a dog named Laika, the first animal to soar into space. The United States launched its first satellite, *Explorer I,* on Jan. 31, 1958, and its second, *Vanguard I,* on March 17, 1958. These satellites were much smaller than the Sputniks, because the American launch vehicles were not as powerful as those used by the Russians.

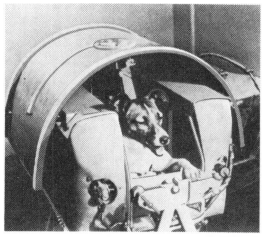
The United States launched many more scientific satellites into orbit and began to make practical use of space. In December of 1958, the United States launched the first communications satellite in a flight called *Project Score.* In February, 1959, the first weather satellite, *Vanguard II,* sent pictures of clouds to earth. Russia launched far fewer satellites than the United States. But the Russian spacecraft continued to be much larger and heavier than U.S. craft.

Rockets into Outer Space. Early in 1959, first Russia and then the United States launched probes that escaped earth's gravity. Russia's *Luna 1* and the U.S. *Pioneer IV* were aimed at the moon. They zoomed past the moon and went into orbit around the sun as the first man-made *planetoids.* In the following years, both the United States and Russia sent many spacecraft to the moon and the planets, and around the sun.

Man in Space. In the early 1960's, man himself began to travel in space. On April 12, 1961, Russian cosmonaut Yuri Gagarin made a single orbit around the earth. The American astronaut Alan Shepard, on May 5, 1961, rocketed to a height of 116½ miles (187.5 kilometers) in a flight 300 miles (480 kilometers) long. Cosmonaut Gherman Titov made 16 revolutions of the earth on Aug. 6-7, 1961. John H. Glenn, Jr., first American

astronaut to orbit the earth, made three revolutions on Feb. 20, 1962. These men were followed by an ever increasing number of astronauts and cosmonauts.

Russian manned flights of the early 1960's maintained an edge over those of the United States. With its powerful launching rockets, Russia could orbit large spacecraft carrying enough life-support equipment to keep a man in space for several days. Several cosmonauts made *group flights* in which two pilots orbited earth at the same time in separate spacecraft. In such a flight, Valentina Tereshkova, the first woman to fly in space, orbited earth for almost three days, June 16-18, 1963, during Valery Bykovsky's flight. On Oct. 12, 1964, Russia achieved another first in space by sending three cosmonauts into orbit in one spacecraft, the *Voskhod I*.



Sovfoto

Laika, the Russian Space Dog, was the first animal sent into orbit. Laika rode in *Sputnik II* in 1957. Studies of animals in space helped pave the way for manned space travel.

Tragedy struck the U.S. space program on Jan. 27, 1967, when three Apollo astronauts were killed in a test of their spacecraft. Virgil I. Grissom, Edward H. White II, and Roger B. Chaffee died when fire and smoke swept their command module during a ground checkout at the John F. Kennedy Space Center. The three men had been scheduled to fly the first manned Apollo spacecraft on Feb. 21, 1967.

The fire probably began with a spark from faulty electrical wiring. The spark ignited items in the cabin of the module, and the fire broke out. The tragedy caused a 20-month delay in the first manned Apollo flight. Many safety features were added to the Apollo spacecraft to prevent a similar accident from occurring.

The first known space flight death occurred in April, 1967. Cosmonaut Vladimir Komarov was killed when his spacecraft's parachute failed. In June, 1971, three more Soviet cosmonauts were killed. The cosmonauts, Georgi Dobrovolsky, Victor Patsayev, and Vladislav Volkov, had completed 24 days orbiting the earth aboard an experimental space station called *Salyut*. The three were found dead in their *Soyuz XI* spacecraft after it had made an apparently normal landing.

America's first man-in-space project was the Mercury program. The first Mercury flight was in April, 1961, and the last in May, 1963. The nation's next steps into space were the Gemini and Apollo programs. The first manned flight in the Gemini program was made in March, 1965, and the last in November, 1966. The first manned Apollo flight was made in October, 1968.

The first men on the moon were astronauts Neil A. Armstrong and Edwin E. Aldrin, Jr. Their Apollo 11 lunar module landed on July 20, 1969. Armstrong, Aldrin, and command module pilot Michael Collins left the earth on July 16 and returned on July 24.

The Space Race. Many persons tried to compare the space accomplishments of the United States and Russia to see which country was "ahead." But differences in the two space programs made comparisons difficult. In the early 1960's, Russia had powerful rockets that could launch heavy spacecraft on long flights. But the United States led in the number of scientific spacecraft it had launched, and in such fields as communications and weather-reporting by satellite.

By the early 1970's, U.S. astronauts had landed on the moon. Unmanned Russian spacecraft had explored the moon and brought soil samples to earth. Manned exploration of the moon by the United States ended in 1972. Both countries experimented with manned space stations that orbited the earth.

In 1975, the United States and Russia undertook their first joint space mission, the Apollo-Soyuz Test

NASA

A Walk in Space by Edward H. White II was the first of several space walks in the Gemini program. The astronauts practiced maneuvering to prepare for future work in space.

NASA

How the Earth Looks from the Moon. The Apollo 8 astronauts took this picture while orbiting the moon. They were less than 100 miles (160 kilometers) from the moon and more than 240,000 miles (386,000 kilometers) from the earth. Africa is at the bottom of the lighted area of the earth.

Project. On July 16, a three-man U.S. Apollo spacecraft docked with a two-man Russian Soyuz craft. Crew members conducted joint scientific experiments for two days before carrying out separation maneuvers.

Activities in Other Countries. Many countries cooperate with the United States in the exploration and the practical use of space. Great Britain, Canada, and Italy build satellites and satellite instruments to be launched by American rockets. A number of countries use U.S. sounding rockets for space research. These countries include Argentina, Australia, Canada, Denmark, France, Germany, India, Italy, Japan, New Zealand, Norway, Pakistan, and Sweden.

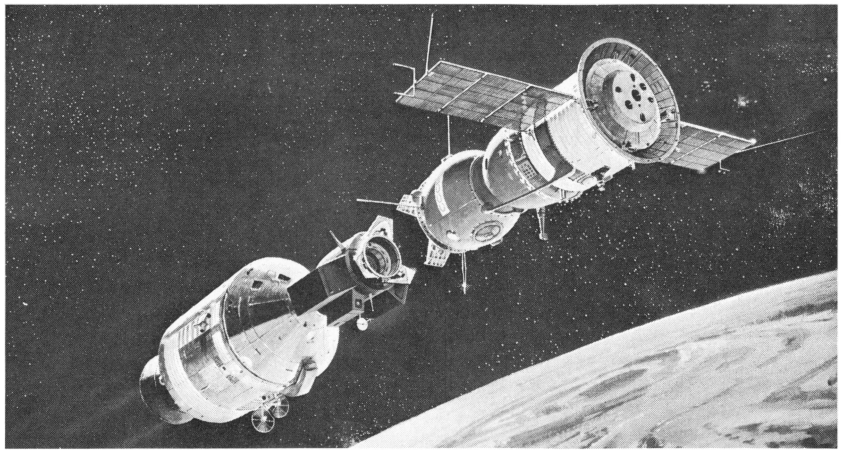
The nations of Western Europe have formed special organizations to promote the development of a cooperative space program. The European Space Research Organization (ESRO) was established in 1962 to coordinate the research activities of its member nations. Also in 1962, the European Space Vehicle Launcher Development Organization was founded to design launch vehicles for satellites. In 1975, these two groups combined to form the European Space Agency (ESA).

Several countries have launched satellites with their own launch vehicles. France launched a 92-pound (42-kilogram) satellite on Nov. 26, 1965. Japan placed a 50-pound (23-kilogram) satellite in orbit on Feb. 12, 1970. China launched a 380-pound (172-kilogram) satellite on April 25, 1970.

The International Astronautical Federation (IAF) was established in 1950 to encourage space research and to promote space flight as a peaceful project. This organization includes 55 rocket societies of more than 36 countries. The Committee on Space Research (COSPAR) of the International Council of Scientific Unions was formed in 1958 to further international scientific investigations which use rockets.

In 1967, the United States, Russia, and many other countries signed a treaty providing for the peaceful exploration and use of outer space. The treaty banned the use of nuclear weapons in outer space.

NASA



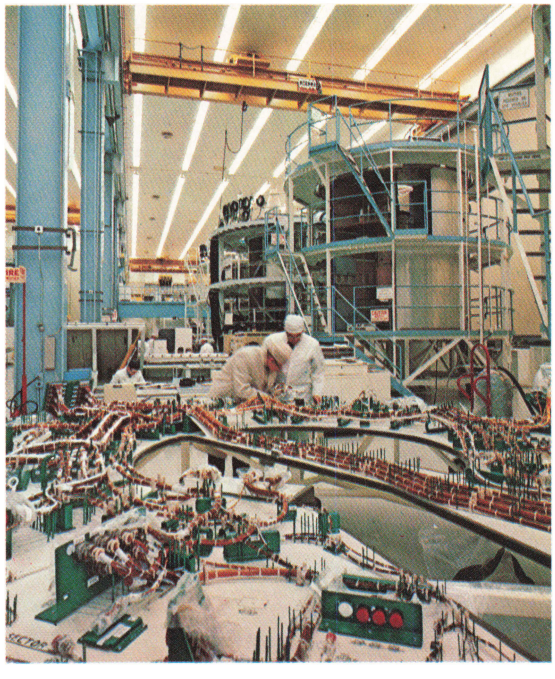
The First Joint Space Mission between the United States and Russia took place in 1975. It was highlighted by the docking of the three-man U.S. Apollo spacecraft, *left*, with the two-man Russian Soyuz capsule, *right*. The crews of the two spacecraft tested equipment and techniques for possible future international rescues in space.

Rockwell International Corp.

Huge F-1 Rocket Engines are shown during manufacturing. Each engine provides 1½ million pounds (6.7 million newtons) of thrust. Five F-1's powered the first stage of the Saturn V rocket.

Electrical Harnesses for Service Modules of Apollo spacecraft are assembled by skilled technicians. The service modules, *background*, carry support systems for the spacecraft.

Rockwell International Corp.



The aerospace industry includes many kinds of companies. Some firms design and build aircraft, missiles, and space vehicles. Others manufacture systems, such as life-support and navigational equipment. Still others furnish consulting and research services on space problems. Aerospace firms range in size from a small machine shop working on a single part to a great industrial organization with thousands of workers building giant rocket stages. Many electronics firms are also considered part of the aerospace industry.

The aerospace industry began as an extension of the aviation industry. The word *aerospace* is a combination of *aero* (meaning *air*) and the word *space*. In general, an aerospace company is one whose products or services are related to air travel and to space travel.

In the United States, about 10,000 firms work on aerospace projects. The firms are located primarily along the West Coast and in the New England States. A secondary grouping lies in the industrial Midwest. Other aerospace centers have developed in the Gulf States and in the Middle Atlantic States and the Southeastern States. In the mid-1970's, the aerospace industry employed more than 900,000 workers and topped $\$13\frac{1}{2}$ billion in sales. Production and employment depend on government funds appropriated by Congress for space and missile programs.

The total production of the aerospace industry involves many products used in industry and the home. Such products include miniature electronic devices for television receivers, and special ceramic materials used to make frypans. These products are not the direct result of space programs, but they are made possible by aerospace research and development projects.

In the United States, the National Aeronautics and Space Administration (NASA) directs the main national space activities such as the Mercury, Gemini, and Apollo programs. This agency selects space programs and manages the research and development of spacecraft and launch vehicles. It operates the Launch Operations Center at Cape Canaveral, the Lyndon B. Johnson Space Center near Houston, and several research and development installations such as the Marshall Space Flight Center in Huntsville, Ala., and the Lewis Research Center in Cleveland. The Department of Defense (DOD) also conducts space programs through the Air Force, Army, and Navy. These programs include the development of missiles such as Polaris and Titan II, military communications satellites, and navigational satellites such as Transit.

Making Aerospace Equipment. Most companies do not manufacture an entire spacecraft or launch vehicle for a space program. Usually, a single company is chosen to manage the production of the vehicle. This firm is called the *prime contractor*. It breaks down the main task into smaller jobs, and assigns many of these jobs to other firms called *subcontractors*. For example, in the manufacture of a launch rocket, one firm might manufacture the engine, another the fuel tanks, and a third the guidance system. In some cases, several hundred firms may supply the prime contractor with

various items. The subcontractors themselves often divide up their own portions of the task and contract with still more firms for parts and equipment. After the parts have been made, they are delivered to the prime contractor for final assembly.

To select a contractor for a project, a government agency, such as the Department of Defense, first sends out invitations to various companies for bids on the job. Each company can then make its bid in a detailed *proposal*. The proposal usually contains preliminary designs, time schedules, cost figures, and a brief account of the company's experience and abilities in the particular field. The government agency then carefully reviews the proposals. It awards the contract to a particular company on the basis of the company's bid and on its qualifications.

In special cases, a single firm may be exceptionally qualified for a particular job. The government agency then arranges the terms of the contract with this firm without requesting bids. Such a company is known as a *sole source*.

The manufacture of a space vehicle differs greatly from the building of an airplane. Spacecraft cannot be built on an assembly line. Highly trained engineers and technicians must make and assemble the complicated parts with the utmost precision. For example, certain vehicles and space equipment must be manufactured and assembled in a special area called a *clean room*. This room is carefully conditioned with filtered air to prevent even the smallest particles of dust from reaching the equipment. Technicians working in the room wear special lint-free clothing, and look much like doctors in an operating room.

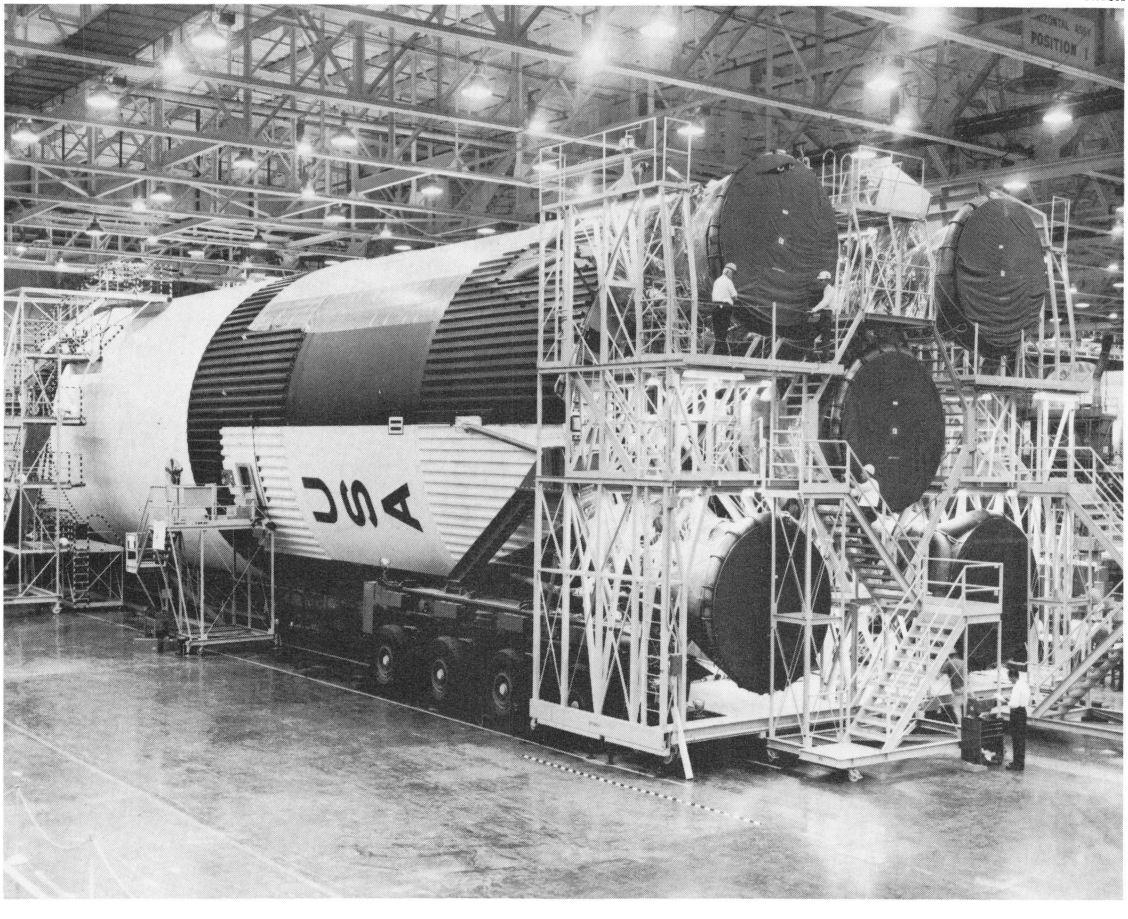
Space Age Careers include perhaps the most exciting career of all—exploring space as an astronaut. But at present only a few persons can enter and enjoy this career. See ASTRONAUT.

However, a great number of persons can share in the exploration of space by working in the aerospace industry. Opportunities are open to almost every kind of scientist and engineer, and to business administrators, doctors, and technicians.

Scientists play a major role in designing experiments to be performed by satellites and space probes. They also do basic research on new materials for building spacecraft and on new forms of rocket propulsion.

The First Stage of a Giant Saturn V Launch Vehicle is inspected by technicians at an assembly plant. The first stage is 33 feet (10 meters) in diameter and 138 feet (42 meters) tall. It boosted an Apollo spacecraft on the first leg of a journey to the moon.

NASA



SPACE TRAVEL

Biologists and biochemists devise tests to show whether life may exist on a planet such as Mars. Physicists plan experiments to study radiation in space, the earth's magnetic field, and the conditions on distant planets. Meteorologists and geophysicists work out ways to study the speed and direction of the solar wind, the temperature and pressure of earth's atmosphere, and the size and shape of the earth.

Specialists in nuclear physics and plasma physics work on propulsion systems such as nuclear rockets and ion rockets. Chemists and metallurgists conduct research on new materials that withstand the heat of a rocket exhaust or the impact of meteoroids. Mathematicians analyze the information radioed back from instruments speeding through space. They use computers to find a launch vehicle's *reliability* (its chances of making a successful launch). Psychologists measure the astronaut's performance during a space flight. Even economists and sociologists take part in the space program by studying the effect of space travel on education and employment. Political scientists work out solutions to space problems in international law.

Engineers of all kinds carry the greatest responsibility in the space program. Engineers design and launch the space vehicles and develop the equipment used in tracking and telemetry. They plan and build the instruments that explore in space, and find the best way of sending the instruments to their destination. They design and build the launch pads, gantries, control rooms, and other ground equipment needed to launch men and instruments into space.

Specialists in human engineering plan manned spacecraft so that the astronaut can work comfortably and efficiently. Mechanical engineers design and build machines that can land on the moon and dig out samples of the moon's surface for analysis. Electronics and communications engineers work on radio transmitters and receivers for tracking and controlling spacecraft. Hydraulic engineers and specialists in low-temperature physics design pumping systems to handle new fuels discovered by research chemists. Metallurgical engineers and specialists in ceramics develop protective coverings for manned spacecraft.

Technicians include trained specialists who manufacture, install, maintain, repair, and operate the complicated equipment used in launching a spacecraft. Technicians may specialize in working with metals, plastics, ceramics, and various other materials. They put together the complicated electronics equipment used in spacecraft guidance and control systems. They also inspect manufactured parts and test assembled equipment to see that it works properly.

Students interested in aerospace careers should take as much science and mathematics as possible in high school. For professional positions, the aerospace worker must have at least a bachelor's degree in science or engineering. Students who wish to become technicians can take their training at technical institutes. Information on space age careers can be obtained from the United States Office of Education, Division for Aerospace Education, Washington, D.C.; the Aerospace Industries Association of America, Inc., Washington, D.C.; the National Aeronautics and Space Administration, Washington, D.C.; and the American Institute of Aeronautics and Astronautics, 1290 Avenue of the Americas, New York, N.Y. 10019. HAROLD L. GOODWIN

Critically reviewed by WERNHER VON BRAUN

Related Articles. For information on the astronauts and cosmonauts themselves and on how they are selected and trained, see the ASTRONAUT article. See also the following articles:

BIOGRAPHIES

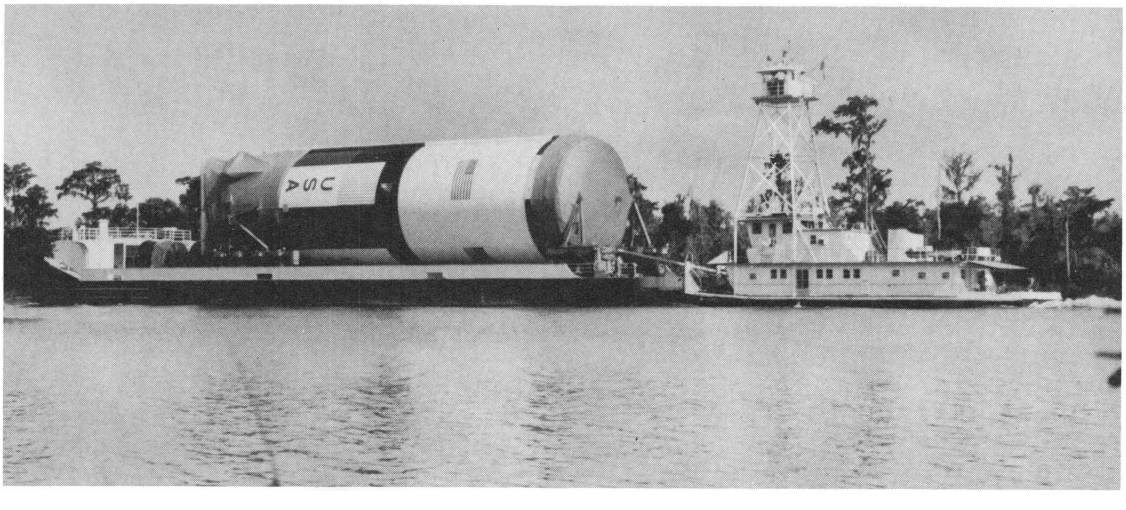
For a list of WORLD BOOK biographies on astronauts and cosmonauts, see the *Related Articles* at the end of the ASTRONAUT article. See also: GODDARD, ROBERT H.; KUIPER, GERARD PETER; VON BRAUN, WERNHER.

ORGANIZATIONS

American Institute of Aeronautics and Astronautics
Communications Satellite Corporation
European Space Agency
National Aeronautics and Space Administration

A Rocket Carried by Barge was the first stage of a moon rocket. This stage, which delivered 7½ million pounds (33 million newtons) of thrust, was too large to be carried by trucks or train.

NASA



OTHER RELATED ARTICLES

Astronautics
Aviation Medicine
Brooks Air Force Base
Cape Canaveral
Centrifugal Force
Communications Satellite
Cosmic Rays
Exobiology
Gravitation
Guided Missile
Heat Shield
International Years of the Quiet Sun
Jet Propulsion
Jet Propulsion Laboratory
Jodrell Bank Observatory
Jupiter (Flights to Jupiter)
Lyndon B. Johnson Space Center
Meteor
Moon
Orbit
Planet
Radiation
Relativity
Rocket
Solar Energy
Solar System
Telemetry
United Nations (Peaceful Uses of Outer Space)

Outline

I. What Is Space
- A. The Beginning of Space
- B. From Earth to the Moon
- C. Space Among the Planets
- D. To the Stars and Beyond

II. Getting into Space and Back
- A. Overcoming Gravity
- B. Returning to Earth

III. Launch Vehicles
- A. The Building Block Idea
- B. Piggyback Boosters
- C. Space Shuttle Systems

IV. Manned Spacecraft
- A. Life-Support Systems
- B. Communications and Navigation Equipment
- C. Control Systems
- D. Re-Entry and Landing Equipment

V. Launch Operations

VI. Flying a Spacecraft
- A. Before the Flight
- B. Piloting a Spacecraft
- C. Scientific Duties
- D. Living in a Spacecraft
- E. Re-Entry

VII. Orbiting the Earth
- A. Selecting the Orbit
- B. Launching a Spacecraft
- C. How a Spacecraft Stays in Orbit

VIII. Reaching the Moon
- A. Aiming at the Moon
- B. Orbiting the Moon
- C. Landing on the Moon
- D. Exploring the Moon
- E. Returning to Earth

IX. Space Stations
- A. Space Station Laboratories
- B. Stopping-Off Places for Spaceships

X. Reaching the Planets and the Stars
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- B. Traveling to the Planets
- C. Reaching the Stars

XI. Problems of Space Flight
- A. Dangers in Space
- B. Tracking a Spacecraft
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XII. Artificial Satellites
- A. Weather Satellites
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- D. Scientific Satellites
- E. Military Satellites

XIII. Space Probes
- A. Sounding Rockets
- B. Lunar Spacecraft
- C. Interplanetary Probes
- D. Planetary Probes

XIV. Steps in the Conquest of Space
- A. Early Developments
- B. High-Altitude Rockets
- C. Man-Made Moons
- D. Rockets into Outer Space
- E. Man in Space
- F. The Space Race
- G. Activities in Other Countries

XV. The Aerospace Industry
- A. Making Aerospace Equipment
- B. Space-Age Careers

Questions

What two men are called "the fathers of space flight"?
What is a retrorocket? A heat shield?
How far above earth does space begin?
How does a rocket engine produce thrust?
What is a *clean room?*
What was the first international satellite?
At what speed must a spacecraft be launched to reach the moon? To escape earth's gravity?
How do engineers use the "building block idea" to design launch vehicles?
What holds a satellite up?
What space probes photographed the far side of the moon?
What probe measured the temperature of the planet Venus?

Reading and Study Guide

See *Space Travel* in the RESEARCH GUIDE/INDEX, Volume 22, for a *Reading and Study Guide.*

Books for Young Readers

ASIMOV, ISAAC. *A B C's of Space.* Walker, 1969.
BRANLEY, FRANKLYN M. *Man in Space to the Moon.* Crowell, 1970.
CLARKE, ARTHUR C. *Into Space: A Young Person's Guide to Space.* Rev. ed. Harper, 1971.
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SPACECRAFT. See SPACE TRAVEL.

S.P.A.D. See AIR FORCE (picture: Fighting Planes).

SPAGHETTI. See MACARONI.

SPAGNOLETTO, LO. See RIBERA, JUSEPE DE.

SPAHN, WARREN (1921-), became one of the greatest pitchers in baseball history. During his major league career, he won 363 games, more than any other left-handed pitcher. Spahn won 20 or more games in one season 13 times, and he led the National League in games won eight times. He holds the National League record for the most shutouts by a left-handed pitcher, 63.

Warren Edward Spahn was born in Buffalo, N.Y. He played for the Boston (later Milwaukee) Braves from 1942 to 1964. In 1965, Spahn pitched for the New York Mets and San Francisco Giants. He retired after the 1965 season. Spahn was elected to the National Baseball Hall of Fame in 1973. JOSEPH P. SPOHN

SPAIGHT, *spate,* **RICHARD DOBBS** (1758-1802), was a North Carolina signer of the United States Constitution. He was a delegate to the Congress of the Confederation from 1783 to 1785. In the Constitutional Convention, he favored election of the President by Congress. Later, he worked for the ratification of the Constitution in North Carolina. He was governor of North Carolina from 1792 to 1795. He served in the U.S. House of Representatives from 1798 to 1801. Spaight was born in New Bern, N.C. ROBERT J. TAYLOR

J. Ciganovic from Madeline Grimoldi

The Countryside of Spain consists mostly of plains broken by hills and low mountains. Most of the land has poor soil for growing crops, and so many farmers raise sheep and other livestock. Whitewashed houses with tile roofs, such as the village homes above, are common in rural Spain.

SPAIN

SPAIN is a country in Western Europe famous for its colorful bullfights, sunny climate, and beautiful storybook castles. Until the mid-1900's, Spain was one of the most underdeveloped countries of Western Europe. Most of the people were poor farmers. Then during the 1950's and 1960's, rapid economic development changed Spain into an industrial nation.

Today, more Spaniards work in the manufacturing and construction industries than on farms, and about half the people live in cities. The standard of living has risen rapidly, and modern urban ways of life have become increasingly popular. Many old customs, such as taking a *siesta* (nap or rest) after lunch, are disappearing.

Spain occupies most of the Iberian Peninsula, which lies in southwestern Europe between the Atlantic Ocean and the Mediterranean Sea. Portugal occupies the rest of the peninsula. Spain's capital and largest city, Madrid, stands in the center of the country.

On Spain's northeastern border, the mighty Pyrenees Mountains separate Spain from France. These mountains once were a great barrier to overland travel between the Iberian Peninsula and the rest of Europe. In contrast, Africa lies only about 10 miles (16 kilometers) south of Spain across the Strait of Gibraltar, and peoples from northern Africa helped shape Spain's early history. These peoples included Carthaginians and Moors.

Carthaginians ruled much of Spain from the 400's to the 200's B.C. In the A.D. 700's, Moors conquered most of Spain, and they held control for hundreds of years. Ancient Celtic peoples and Greeks also settled in Spain, and the ancient Romans made the peninsula a province of their huge empire.

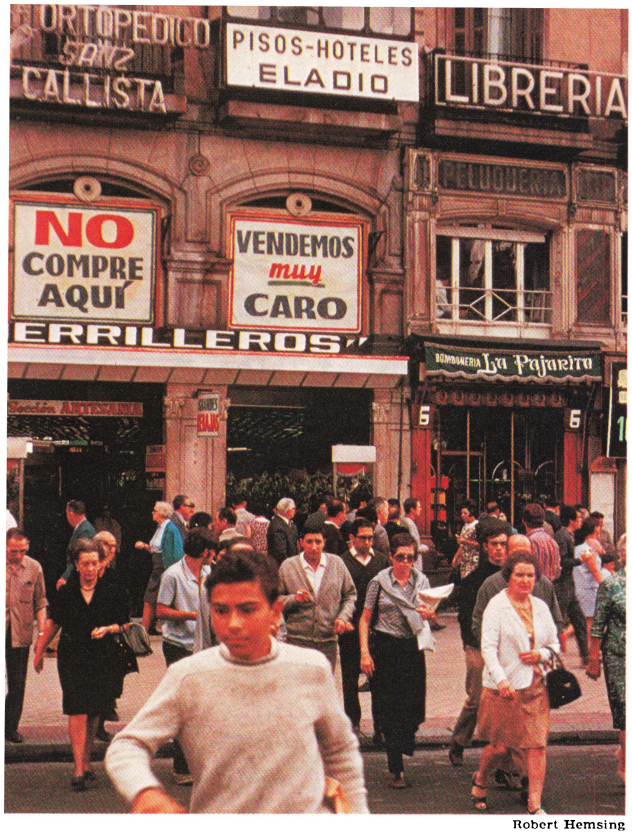
The Spaniards have had to struggle against many natural handicaps, as well as against invasions by Moors, Romans, and other peoples. Most of Spain is a high, dry plateau called the *Meseta*. Hills and mountains rise throughout the Meseta, and north of it a mountain barrier extends across the peninsula. This rugged landscape makes travel through Spain difficult.

Spain also lacks many raw materials needed by industry, and crops do not grow well in the country's poor soil and dry climate. As a result, the Spaniards have historically produced little that could be offered in trade with other countries. But in spite of their many disadvantages, the proud, strong-willed Spaniards once ruled one of the largest empires in world history.

Spain's rise as a world power started in the A.D. 1000's, when the Spanish people began to drive the Moors from the country. They finally defeated the Moors in 1492. That same year, Christopher Columbus, sailing in Spanish ships, reached America.

Columbus' voyage touched off a great age of Spanish exploration and conquest. The Spaniards built an empire that included much of western South America and

Stanley G. Payne, the contributor of this article, is Professor of History at the University of Wisconsin at Madison and the author of Franco's Spain *and other books about Spain.*



Robert Hemsing

The Streets of Madrid, Spain's capital and largest city, are usually crowded with people. Madrid is one of the chief commercial, cultural, and industrial centers of the country.

southern North America, as well as lands in Africa, Asia, and Europe. But beginning in the late 1500's, economic difficulties, wars with other countries, and civil wars weakened Spain, and the country lost most of its huge empire. Spain then remained a poor, weak nation until the mid-1900's.

In the late 1930's, a bloody civil war tore Spain apart and brought General Francisco Franco to power as dictator. He has controlled the country ever since.

FACTS IN BRIEF

Capital: Madrid.

Official Language: Castilian Spanish.

Form of Government: Dictatorship (officially a kingdom).

Area: 194,885 sq. mi. (504,750 km²), including Balearic and Canary islands. *Greatest Distances*—east-west, 646 mi. (1,040 km); north-south, 547 mi. (880 km). *Coastline*—2,345 mi. (3,774 km).

Elevation: *Highest*—Mulhacén, 11,411 ft. (3,478 m) above sea level. *Lowest*—sea level along the coast.

Population: *Estimated 1976 Population*—36,043,000; distribution, 52 per cent urban, 48 per cent rural; density, 184 persons per sq. mi. (71 persons per km²). *1970 Census*—33,823,918. *Estimated 1981 Population*—38,012,000.

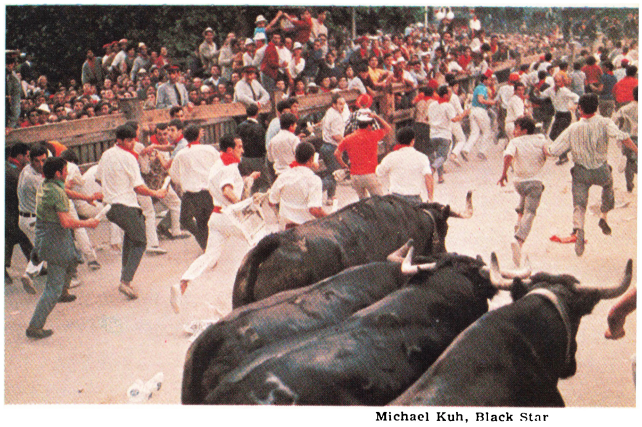
Chief Products: *Agriculture*—olives, oranges, wheat, wine grapes. *Manufacturing*—automobiles, cement, chemical products, clothing, ships, steel.

National Anthem: "Himno Nacional" ("National Anthem").

Money: *Basic Unit*—peseta. See MONEY (table); PESETA.

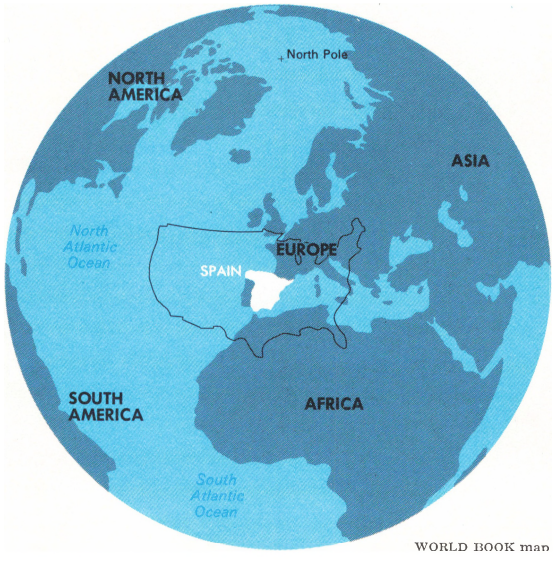
J. Ciganovic from Madeline Grimoldi

Beautiful Castles called *alcazars,* built during the Middle Ages, stand in many Spanish cities. The alcazar above is in Segovia.



Michael Kuh, Black Star

Local Festivals are celebrated throughout Spain each year. During the *fiesta* (festival) of San Fermin in Pamplona, above, the people run bulls through the streets to the bull ring.



WORLD BOOK map

Spain has an area more than 6 per cent as large as that of the United States, not including Alaska and Hawaii.

SPAIN

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6
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44° North Latitude
8°
4° West Longitude
0°
36°
Bay of Biscay
Mediterranean Sea
North Atlantic Ocean
Costa del Sol
Costa Blanca
Strait of Gibraltar
PORTUGAL
MOROCCO
ALGERIA
GIBRALTAR
(Great Britain)
Ceuta (Spain)
Melilla (Spain)
Cape Finisterre
Ortigueira
El Ferrol
La Coruña
Carballo
Villalba
Avilés
Gijón
Villaviciosa
Luarca
Oviedo
Tineo
Mieres
Siero
Sama
Laviana
Cangas
Lena
Llanes
San Vicente
Camargo
Santander
Torrelavega
Portugalete
Baracaldo
Bilbao
Basauri
Éibar
San Sebastián
Irún
Bayonne
Pau
Renteria
Beasain
Santiago
Lugo
Villablino
La Estrada
Ribeira
Villagarcía
Lalín
Mino
Pontevedra
Marina
Cangas
Redondela
Vigo
Puenteareas
Monforte
Ourense
Ponferrada
El Barco
Astorga
León
Guardo
Vitoria
Miranda
Pamplona
Jaca
Briviesca
Logroño
Calahorra
Burgos
Esla
Verín
Benavente
Palencia
Tudela
Ejea
Huesca
Ebro
Tarazona
Soria
Saragossa
Braga
Zamora
Toro
Valladolid
Aranda
El Burgo
Duero (Douro)
Almazán
Porto
Douro (Duero)
Medina
Cuéllar
Calatayud
Caspe
Alcañiz
Andorra
Sigüenza
Salamanca
Peñaranda
Segovia
Molina
Ciudad-Rodrigo
Ávila
Guadalajara
Béjar
Alcobendas
Madrid
Alcalá
Alcorcón
Torrejón
Getafe
Móstoles
Teruel
Coimbra
Covilhã
Coria
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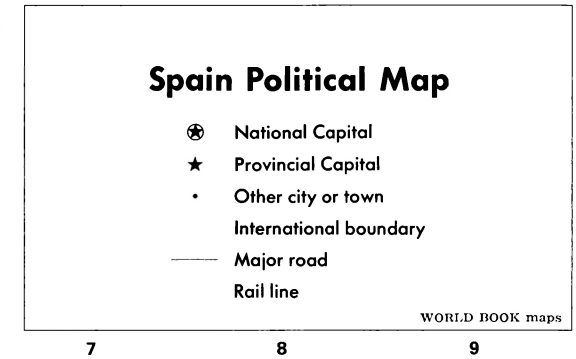
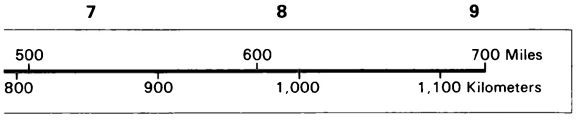
Sagunto
Valencia
Cáceres
Trujillo
Alcázar
Villarrobledo
Requena
Torrente
Júcar
Tomelloso
Sueca
Alcira
Guadiana
Ciudad Real
Daimiel
Manzanares
Albacete
Játiva
Gandía
Lisbon
Badajoz
Mérida
Villanueva
Don Benito
Almansa
Onteniente
Alcoy
Setubal
Évora
Almendralejo
Castuera
Puertollano
Valdepeñas
Hellín
Yecla
Villena
Jumilla
Elda
Alicante
Elche
Orihuela
Jerez
Azuaga
Peñarroya
La Carolina
Cieza
Caravaca
Molina
Alcantarilla
Murcia
Beja
Aracena
Córdoba
Guadalquivir
Andújar
Úbeda
Linares
Jaén
Baena
Martos
Nerva
Valverde
Lora
Écija
Montilla
Lorca
Cartagena
Carmona
Seville
Alcalá
Puente Genil
Cabra
Alcalá
Baza
Águilas
Portimão
Ayamonte
Huelva
Dos Hermanas
Marchena
Lucena
Guadix
Isla Cristina
Utrera
Osuna
Loja
Genil
Granada
Lebrija
Antequera
Nijar
Sanlúcar
Arcos
Ronda
Vélez-Málaga
Dalías
Almería
El Puerto
Jerez
Coín
Málaga
Motril
Adra
Cádiz
Puerto Real
Marbella
San Fernando
Chiclana
Estepona
Algeciras
Tarifa
Tangier
0
100
200
300
400
500
600
700





REGIONS AND PROVINCES OF SPAIN

The table and map below identify the historic regions of Spain and the provinces into which they are divided. Each province is numbered on the map to correspond to its name in the table.

	Population	Area In sq. mi.	Area In km²
Andalusia (Andalucía)	5,971,277	33,694	87,267
1 Almería	375,004	3,388	8,775
2 Cádiz	885,433	2,851	7,384
3 Córdoba	724,116	5,296	13,717
4 Granada	733,375	4,838	12,530
5 Huelva	397,683	3,894	10,085
6 Jaén	661,146	5,212	13,499
7 Málaga	867,330	2,809	7,275
8 Sevilla	1,327,190	5,406	14,001
Aragon (Aragón)	1,152,708	18,405	47,669
1 Huesca	222,238	6,050	15,669
2 Teruel	170,284	5,716	14,804
3 Zaragoza	760,186	6,639	17,195
Asturias	1,045,635	4,079	10,565
Oviedo	1,045,635	4,079	10,565
Balearic Islands (Baleares)	558,287	1,936	5,014
Baleares	558,287	1,936	5,014
Basque Provinces and Navarre (Vascongadas y Navarra)	2,343,503	6,827	17,682
1 Alava	204,323	1,176	3,046
2 Guipúzcoa	631,003	771	1,997
3 Navarra	464,867	4,024	10,422
4 Vizcaya	1,043,310	856	2,217
Canary Islands (Canarias)*	1,170,224	2,808	7,273
1 Las Palmas*	579,710	1,569	4,064
2 Santa Cruz de Tenerife*	590,514	1,239	3,209
Catalonia (Cataluña)	5,122,567	12,328	31,929
1 Barcelona	3,929,194	2,986	7,734
2 Gerona	414,397	2,272	5,884
3 Lérida	347,015	4,644	12,028
4 Tarragona	431,961	2,426	6,283
Estremadura (Extremadura)	1,145,376	16,063	41,603
1 Badajoz	687,599	8,362	21,657
2 Cáceres	457,777	7,701	19,945
Galicia	2,583,674	11,365	29,435
1 La Coruña	1,004,188	3,041	7,876
2 Lugo	415,052	3,785	9,803
3 Orense	413,733	2,810	7,278
4 Pontevedra	750,701	1,729	4,476
Leon (León)	1,172,262	14,812	38,363
1 León	548,721	5,972	15,467
2 Salamanca	371,607	4,763	12,336
3 Zamora	251,934	4,077	10,559
Murcia	1,167,339	10,106	26,174
1 Albacete	335,026	5,737	14,859
2 Murcia	832,313	4,369	11,316
New Castile (Castilla la Nueva)	5,164,026	27,940	72,364
1 Ciudad Real	507,650	7,625	19,749
2 Cuenca	247,158	6,587	17,060
3 Guadalajara	147,732	4,707	12,191
4 Madrid	3,792,561	3,087	7,995
5 Toledo	468,925	5,934	15,369
Old Castile (Castilla la Vieja)	2,153,785	25,524	66,107
1 Ávila	203,798	3,107	8,047
2 Burgos	358,075	5,509	14,268
3 Logroño	235,713	1,944	5,035
4 Palencia	198,763	3,100	8,029
5 Santander	467,138	2,042	5,289
6 Segovia	162,770	2,683	6,949
7 Soria	114,956	3,972	10,287
8 Valladolid	412,572	3,167	8,202
Valencia	3,073,255	8,998	23,305
1 Alicante	920,105	2,264	5,864
2 Castellón	385,823	2,579	6,680
3 Valencia	1,767,327	4,155	10,761

*Does not appear on map. Source: Latest census (1970).

SPAIN MAP INDEX

Cities and Towns

(Some population figures include a rural area surrounding the city or town.)

Adra ..... 16,283 .. G 5
Aguilar* ... 13,934 .. F 4
Águilas .... 17,389 .. F 6
Alacuás* .. 19,639 .. D 6
Albacete ... 93,233 .. E 5
Alcalá [de Guadaira] 33,999 .. F 3
Alcalá [de Henares] 59,783 .. D 4
Alcalá [la Real] ... 21,349 .. F 4
Alcañiz .... 10,818 .. C 6
Alcantarilla 19,895 .. F 6
Alcaudete* .. 13,626 .. F 4
Alcázar [de San Juan] ... 26,391 .. D 5
Alcira ... 32,876 .. E 6
Alcobendas 25,000 .. D 4
Alcorcón .. 46,048 .. D 4
Alcoy ..... 61,371 .. E 6
Aldaya* .... 16,157 .. D 6
Alfafar* .... 13,093 .. D 6
Algeciras .. 81,662 .. G 3
Algemesí* . 22,123 .. D 6
Alhama de Murcia* .. 11,557 .. F 6
Alhaurín el Grande* .. 11,847 .. G 4
Alicante .. 184,716 .. E 6
Almadén* ... 10,774 .. E 4
Almansa ... 16,965 .. E 6
Almazán .... 4,856 .. C 5
Almazora* . 13,057 .. C 7
Almendralejo ... 21,929 .. E 3
Almería .. 114,510 .. F 5
Almodóvar del Campo* .. 11,637 .. E 4
Almonte* .. 11,566 .. F 2
Almoradí* .. 11,576 .. E 6
Almuñécar* 13,251 .. F 4
Álora* .... 15,602 .. G 4
Amorbieta-Echano* . 12,465 .. A 5
Amposta* .. 12,740 .. C 7
Andoain* .. 11,818 .. A 5
Andorra .... 6,485 .. C 6
Andújar ... 31,464 .. E 4
Antequera . 40,908 .. F 4
Aracena .... 6,804 .. F 2
Aranda [de Duero] .. 18,369 .. C 4
Aranjuez .. 29,548 .. D 4
Arcos [de la Frontera] 25,966 .. G 3
Arganda* .. 11,876 .. D 4
Arfeijo* .... 12,166 .. A 1
Aspe* ..... 13,229 .. E 6
Astorga ... 11,794 .. B 3
Ávila ..... 30,983 .. C 4
Avilés .... 81,710 .. A 3
Ayamonte .. 13,099 .. F 2
Azpeitia* .. 10,797 .. A 5
Azuaga .... 11,171 .. E 3
Badajoz .. 101,710 .. E 2
Badalona . 162,888 .. C 8
Baena ..... 19,781 .. F 4
Baeza* .... 14,834 .. F 4
Bailén .... 13,233 .. F 4
Balaguer .. 11,676 .. B 7
Baracaldo 108,757 .. A 5
Barbastro* . 13,427 .. B 6
Barbate* .. 20,297 .. G 3
Barcelona .. 1,745,142 .. C 8
Basauri ... 41,794 .. A 5
Baza ..... 19,990 .. F 5
Beasain .... 10,095 .. A 5
Beas de Segura* .. 11,162 .. F 4
Béjar ..... 17,576 .. D 3
Benavente . 11,779 .. B 3
Benicarló* . 12,831 .. C 7
Benidorm* . 12,124 .. E 6
Berga* .... 12,285 .. C 8
Berja* .... 11,429 .. F 5
Bermeo* ... 17,745 .. A 5
Bilbao .... 410,490 .. A 5
Blanes .... 16,020 .. B 8
Boiro* ..... 13,867 .. A 1
Bollullos par del Condado* 11,177 .. F 2
Briviesca .... 4,263 .. B 5
Bueu* ..... 11,006 .. B 1
Burgos ... 119,915 .. B 4
Burjasot* .. 23,283 .. D 6
Burlada* .. 13,328 .. A 5
Burriana* .. 22,651 .. C 7
Cabaña-quinta* .. 22,812 .. A 3
Cabra ..... 20,428 .. F 4
Cáceres .... 56,064 .. D 3
Cádiz .... 135,743 .. G 3
Calahorra .. 16,340 .. B 5
Calatayud .. 17,217 .. C 6
Callosa de Segura* . 11,692 .. E 6
Camargo ... 15,541 .. A 4
Camas* .... 21,871 .. F 3
Cambados* 10,644 .. B 1
Campo de Criptana* 13,405 .. E 4
Candás* ... 11,529 .. A 3
Cangas .... 19,026 .. B 1
Cangas [de Narcea] . 19,713 .. A 3
Caravaca ... 18,415 .. E 5
Carballo ... 23,508 .. A 1
Carcagente* 18,971 .. D 6
Carlet* .... 11,742 .. D 6
Carmona .. 24,378 .. F 3
Cartagena 146,904 .. F 6
Caspe ..... 9,030 .. C 6
Castelldefels* .. 13,219 .. C 8
Castellón [de la Plana] .. 93,968 .. D 7
Castrillón* 13,393 .. A 3
Castro del Río* .... 11,089 .. F 4
Castro-Urdiales* 12,401 .. A 4
Castuera .... 8,134 .. E 3
Catarroja* . 15,703 .. D 6
Cehegín* .. 12,489 .. F 6
Chantada* . 10,666 .. A 2
Chiclana [de la Frontera] 27,337 .. G 3
Chirivella* 20,063 .. D 6
Cieza ..... 25,359 .. E 6
Ciudadela* 15,140 .. D 8
Ciudad Real 41,708 .. E 4
Ciudad-Rodrigo . 13,320 .. C 3
Coín ..... 20,283 .. G 4
Colmenar Viejo* .. 12,910 .. D 4
Conil* .... 11,267 .. G 3
Constantina* .... 10,914 .. F 3
Córdoba .. 235,632 .. F 4
Coria .... 10,086 .. D 2
Coria del Río* .... 18,910 .. F 3
Cornellá ... 77,314 .. C 8
Corvera de Asturias* 12,601 .. A 3
Coslada* .. 13,412 .. D 4
Crevillente* 16,901 .. E 6
Cuart de Poblet* .. 20,529 .. D 8
Cudillero* . 10,568 .. A 3
Cuéllar ..... 6,699 .. C 4
Cuenca .... 34,485 .. D 5
Cullera* ... 15,738 .. D 6
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Denia ..... 16,484 .. E 7
Don Benito 26,295 .. E 3
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Durango* .. 22,354 .. A 5
Écija ..... 36,056 .. F 3
Eibar ..... 37,073 .. A 5
Ejea [de los Caballeros] .. 14,163 .. B 6
El Arahal .. 15,970 .. F 3
El Barco ... 7,769 .. B 2
El Burgo [de Osma] .... 5,908 .. C 5
Elche .... 122,663 .. E 6
Elda ..... 41,511 .. E 6
El Ferrol [del Caudillo] 87,736 .. A 2
Elgóibar* .. 13,459 .. A 5
El Puerto [de Santa María] .. 42,111 .. G 3
El Viso del Alcor* ... 11,152 .. F 3
Ermúa* .... 14,563 .. A 5
Esplugas* .. 29,474 .. C 8
Estella* ... 10,371 .. A 5
Estepona .. 21,163 .. G 3
Felanitx* . 12,946 .. D 8
Fene* ..... 11,101 .. A 1
Figueras ... 22,087 .. B 8
Fraga ..... 10,013 .. C 7
Fuengirola* 20,597 .. G 4
Fuenterrabía* .... 10,471 .. A 5
Galdácano* 18,770 .. A 5
Gandía .... 36,342 .. E 6
Gavá* .... 24,213 .. C 8
Gerona .... 50,338 .. B 8
Getafe .... 69,424 .. D 4
Gijón .... 187,612 .. A 3
Ginzo de Limia* .. 10,640 .. B 2
Grado* .... 13,990 .. A 3
Granada .. 190,429 .. F 4
Granollers* 30,066 .. C 8
Guadalajara 31,917 .. C 5
Guadix .... 19,840 .. F 5
Guardo ..... 9,012 .. B 4
Guecho* ... 39,153 .. A 5
Guernica y Luno* . 14,678 .. A 5
Hellín .... 22,152 .. E 6
Hernani* .. 23,338 .. A 5
Hospitalet 241,978 .. C 8
Huelva .... 96,689 .. F 2
Huércal-Overa* .. 11,607 .. F 5
Huesca .... 33,185 .. B 6
Ibi* ..... 13,916 .. E 6
Ibiza* ..... 16,943 .. E 7
Igualada* .. 27,941 .. C 8
Illora* .... 10,775 .. F 4
Inca* .... 16,930 .. D 8
Irún ..... 45,060 .. A 5
Isla-Cristina .. 14,271 .. F 2
Jaca ..... 11,134 .. B 6
Jaén ..... 78,156 .. F 4
Játiva .... 21,578 .. E 6
Jerez ..... 149,867 .. G 3
Jerez [de los Caballeros] .. 11,598 .. E 2
Jódar* .... 12,020 .. F 4
Jumilla ... 20,103 .. E 6
La Algaba* 10,882 .. F 3
La Carolina 15,771 .. E 4
La Coruña 189,654 .. A 1
La Estrada 27,550 .. B 1
Lalín .... 19,405 .. B 2
La Línea* . 52,127 .. G 3
La Puebla de Cazalla* 10,596 .. F 3
La Puebla del Río* 12,841 .. F 3
Laracha* .. 10,898 .. A 1
La Rinconada* ... 14,691 .. F 3
La Roda* .. 11,663 .. E 5
Las Cabezas de San Juan* ... 10,562 .. F 3
La Solana* 13,894 .. E 4
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Lebrija .... 21,712 .. F 3
Leganés* .. 57,537 .. D 4
Lejona* ... 10,571 .. A 5
Lena ..... 14,921 .. A 3
León ..... 105,235 .. B 3
Lepe* ..... 11,826 .. F 2
Lérida .... 90,884 .. B 7
Linares .... 50,516 .. E 4
Liria* ..... 11,323 .. D 6
Llanes .... 15,509 .. A 4
Lluchmayor* .. 13,646 .. D 8
Logroño ... 84,456 .. B 5
Loja ..... 21,656 .. F 4
Lora [del Río] ..... 18,163 .. F 3
Lorca ..... 60,609 .. F 6
Los Palacios y Villafranca* .. 18,484 .. F 3
Luanco* ... 12,714 .. A 3
Luarca .... 19,599 .. A 3
Lucena .... 27,920 .. F 4
Lugo ..... 63,830 .. A 2
Madrid . 3,146,071 .. D 4
Mahón .... 19,279 .. D 9
Málaga ... 374,452 .. G 4
Manacor ... 23,278 .. D 9
Manises* .. 19,945 .. D 6
Manlleu* .. 13,169 .. C 8
Manresa ... 57,846 .. B 8
Manzanares 15,692 .. E 4
Marbella ... 33,203 .. G 3
Marchena .. 20,918 .. F 3
Marín ..... 19,816 .. B 1
Martorell* . 13,086 .. C 8
Martos .... 21,493 .. F 4
Masnou* ... 10,410 .. C 8
Mataró* ... 73,129 .. C 8
Medina [del Campo] .. 16,528 .. C 4
Medina Sidonia* . 13,651 .. G 3
Mérida .... 40,059 .. E 3
Mieres .... 64,552 .. A 3
Miranda [de Ebro] ... 33,905 .. B 5
Mislata* ... 20,020 .. D 6
Moaña* ... 15,060 .. B 1
Molina .... 3,204 .. C 5
Molina [de Segura] .. 23,178 .. F 6
Molins de Rey* .... 14,456 .. C 8
Mollet* .... 20,212 .. C 8
Moncada* .. 13,663 .. D 6
Moncada* .. 22,462 .. C 8
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Monforte . 19,528 .. B 2
Monóvar* . 10,348 .. E 6
Montefrío* . 10,804 .. F 4
Montijo* .. 12,530 .. E 2
Montilla ... 22,059 .. F 4
Montoro* ... 11,928 .. F 4
Monzón .... 14,089 .. B 7
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Moratalla* . 10,549 .. F 6
Morón* .... 29,488 .. F 3
Mos* ..... 11,183 .. B 1
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Mula* ..... 13,922 .. F 6
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Muros* .... 10,305 .. A 1
Narón* .... 21,491 .. A 1
Nerva ..... 10,915 .. F 2
Níjar ..... 10,818 .. F 5
Novelda* .. 17,344 .. E 6
Noya* ..... 11,990 .. A 1
Oleiros* .... 10,457 .. A 1
Oliva* ..... 16,772 .. D 6
Olot ..... 21,244 .. B 8
Olvera* .... 11,515 .. G 3
Oñate* .... 10,645 .. A 5
Onda* .... 15,131 .. C 7
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Pasajes* ... 21,130 .. A 5
Paterna* ... 22,944 .. D 6
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Peñarroya [Pueblonuevo] ... 16,330 .. E 3
Petrel* .... 15,804 .. E 6
Picasent* .. 11,143 .. D 6
Piloña* .... 12,194 .. A 3
Pinos Puente* .. 12,734 .. F 4
Plasencia . 27,174 .. D 3
Plaza* ..... 15,587 .. B 5
Ponferrada . 45,257 .. B 3
Pontevedra . 52,452 .. B 1
Portugalete 45,589 .. A 5
Pozoblanco* 13,317 .. F 4
Pozuelo de Alarcón* . 16,784 .. D 4
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Pravia* .... 11,915 .. A 3
Premiá de Mar* .... 11,284 .. C 8
Priego de Córdoba* 21,229 .. F 4
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Puente-Genil .... 26,442 .. F 4
Puerto Real 19,569 .. G 3
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Quesada* .. 11,164 .. F 4
Redondela . 22,128 .. B 1
Reinosa* .. 10,863 .. A 4
Rentería ... 34,369 .. A 5
Requena ... 17,840 .. D 6
Reus ..... 59,095 .. C 7
Rianjo* .... 10,944 .. A 1
Ribeira .... 21,716 .. B 1
Ripollet* .. 20,197 .. C 8
Ronda ..... 30,080 .. G 3
Roquetas* .. 12,776 .. F 5
Rota* ..... 23,885 .. G 3
Rubí* ..... 25,461 .. C 8
Rute* ..... 11,205 .. F 4
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San Cugat* 20,669 .. C 8
San Feliu de Guixols* . 12,508 .. B 8
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San Javier* 10,500 .. F 6
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San Vicente dels Horts* 14,509 .. C 8
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Torre-Pacheco* 13,087 .. F 6
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Totana* .... 16,107 .. F 6
Trujillo .... 10,587 .. D 3
Tudela .... 20,942 .. B 6
Túy* ..... 12,600 .. B 1
Úbeda .... 30,186 .. F 4
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Vergara* ... 15,148 .. A 5
Verín ..... 8,870 .. B 2
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Vigo ..... 197,144 .. B 1
Viladecáns* 24,483 .. C 8
Villablino . 13,821 .. A 3
Villacarrillo* .12,910 .. F 4
Villafranca de los Barros* .. 12,908 .. E 2
Villafranca del Panadés* 17,546 .. C 8
Villagarcía 24,076 .. B 1
Villajoyosa* 16,258 .. E 6
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Villamartín* 11,554 .. G 3
Villanueva de Arosa* 12,641 .. B 1
Villanueva de Córdoba* 11,270 .. F 4
Villanueva del Arzobispo* .... 10,321 .. F 4
Villanueva de la Serena ..20,573 .. E 3
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Villarrobledo .... 19,963 .. D 5
Villaviciosa 17,213 .. A 3
Villena .... 25,473 .. E 6
Vinaroz ... 13,727 .. C 7
Vitoria ... 136,873 .. B 5
Yecla ..... 20,724 .. E 6
Zafra* ..... 11,977 .. E 2
Zamora .... 49,029 .. C 3
Zaragoza, see Saragossa
Zarauz* .... 11,642 .. A 5
Zumárraga* 11,854 .. A 5

*Does not appear on map; key shows general location.

Source: Latest census (1970).

Spain is officially a kingdom, but the country does not have a king. General Francisco Franco has ruled as dictator since the Spanish Civil War ended in 1939.

Spain has a set of basic laws instead of a written constitution. For example, the Statute Law of the Spanish People of 1945 outlines the rights and duties of Spaniards. This law and most other basic laws were amended by the Organic Law of the State of 1967. The Organic Law also outlines the structure and functions of government in Spain.

Head of State, the nation's highest government authority, is Franco. Upon Franco's death or retirement, Prince Juan Carlos—a grandson of Spain's last king, Alfonso XIII—will become king and thus succeed Franco as head of state. But Juan Carlos will almost certainly have less power than does Franco.

President of the Government is the official name of Spain's head of government. The head of state appoints him to a five-year term. The president, in turn, appoints a 16- to 20-member Council of Ministers to run the various government departments.

Parliament, which is called the *Cortes*, may introduce and discuss legislation. But the Franco government introduces most legislation, and all laws passed by the Cortes are subject to Franco's approval.

The Cortes has 561 members. Heads of families and married women elect 104 members; the head of state appoints 144; and *syndicates* (state-run labor unions) elect 150. Some of the remaining 163 members serve because they hold high offices in professional or educational organizations. The others are elected, either by those organizations or by local government units. All elected Cortes members serve four-year terms.

Local Government. In addition to its territory on the European mainland, Spain includes the Canary Islands, the Balearic Islands, and Spanish Sahara. The Canaries lie off the northwest coast of Africa. The Balearic Islands lie off Spain's east coast. Spanish Sahara is on the northwest coast of Africa.

Spain is divided into 51 provinces. Mainland Spain consists of 47 provinces; the Canary Islands, 2; and the Balearic Islands and Spanish Sahara, 1 each. The army governs Spanish Sahara. The national government appoints a civilian governor for each of the other provinces. In these provinces, the individuals and organizations that elect Cortes members also elect provincial assemblies and city or town councils. The national government or the provincial governor appoints all mayors.

Courts. Spain has three court systems: civil, military, and syndicate. Judges appointed by the national government decide all cases. The civil court system handles most civil and criminal cases. It consists of a supreme court, 15 appeals courts, 50 provincial courts, and more than 9,000 local courts. Military courts handle cases involving military crimes and civilian crimes classified as military rebellion. Syndicate courts decide economic disputes between employers and employees. Spanish Sahara has only military courts.

Armed Forces of Spain consist of an army of about 210,000 men, a navy of about 44,000, and an air force of about 39,000. Men 21 to 35 years old may be drafted for two years of military service.

David Lees, *Life*, © Time Inc.

General Francisco Franco, *right,* dictator of Spain, chose Prince Juan Carlos, *left,* in 1969 as heir to the Spanish throne. Juan Carlos will become king after Franco retires or dies.

Spain's State Flag, used by the government, was adopted in 1938. The unofficial national flag has no coat of arms.

Coat of Arms. The symbols on the shield represent Aragon, Castile, and other historic kingdoms of Spain.

EDISTUDIO, S.A.

Spain's Parliament Building, the Palace of the Spanish *Cortes* (parliament) in Madrid, is the home of the nation's one-house legislature. The building was erected in the mid-1800's.

Most Spaniards were poor rural people before the country's rapid economic development of the 1950's and 1960's. Many of the people owned small farms. Others worked on large estates. The people in each region of the country, such as Andalusia in the south or Castile in central Spain, felt great loyalty to their region. They had little contact with Spaniards in other regions. The nation's greatest unifying force was the Roman Catholic Church. Almost all Spaniards were Roman Catholics, and a Catholic church stood in the center of most villages.

Today, Spain is an industrial nation, and the people live in an increasingly modern urban society. Most Spaniards eat better, dress better, live in better homes, and receive more education and better health care today than ever before. Regionalism and Roman Catholicism remain important forces in Spanish life. But rapid economic and social change has reduced the influence of these forces on many of the people.

Ancestry and Population. People have lived in what is now Spain for more than 100,000 years. At the beginning of recorded history—about 5,000 years ago—a people known as Iberians occupied much of Spain. During the next 4,000 years, other groups came to Spain as conquerors, settlers, or traders. Phoenicians, the first of these groups, were followed by Celts, Greeks, Carthaginians, Romans, Germanic peoples, and Moors. Each group mixed with other peoples in Spain and so helped shape the ancestry of the present-day Spanish people.

Spain has a population of about 36 million. More than half the people live in cities. Spain has two cities with more than a million persons. They are Madrid, the nation's capital and largest city, and Barcelona. The country has 34 other cities with more than 100,000 persons. See the separate articles on Spanish cities listed in the *Related Articles* at the end of this article.

Language. Castilian Spanish is the official language of Spain and is spoken by almost all the people. There are no *dialects* (local forms) of the language, but pronunciation varies slightly from region to region.

Sabine Weiss, Rapho Guillumette

The Basques of northern Spain are one of the nation's many regional population groups. Each group has folk dances, above, and other customs that differ from those of all the others.

Peter Menzel, Stock, Boston

Modern Apartment Buildings, such as the one above in Barcelona, are common in Spanish cities. Almost all city people live in apartments. Children from this apartment building attend the school connected to it at the left.

Spaniards in three northern regions—Catalonia, the Basque provinces, and Galicia—speak a second language in addition to Castilian Spanish. Many people in Catalonia speak Catalan, a language similar to the Provençal tongue of southern France. Some people in the Basque provinces speak Basque, which is not known to be related to any other language. In Galicia, most people speak a dialect of Portuguese known as Galician. The people who speak Basque, Catalan, or Galician generally use it only when at home or among friends. Otherwise, they use Spanish. See SPANISH LANGUAGE.

City Life. The standard of living in Spanish cities has risen rapidly since the 1950's, and modern urban ways of life have become increasingly popular. Almost all city people live in apartments, and many of them own rather than rent their dwellings. City people wear the latest Western-style clothing, and they dress up somewhat more than do people in the United States. Almost all city homes have electricity, and a rapidly growing number of families own automobiles and television sets. But the people also suffer from such problems as pollution and traffic jams.

People in the cities still follow a number of age-old customs in addition to the latest trends. For example, most Spanish factories, stores, and offices close for three-hour lunch breaks and then stay open until about 7 P.M. Some Spaniards take a siesta after lunch, though most people no longer follow this old custom. Spaniards enjoy a *paseo* (walk) before their evening meal, which they often do not eat until 10 or 11 P.M. They also go to sidewalk cafes, bars, and clubs, where they visit with friends and drink coffee, soft drinks, or wine.

Country Life in Spain has changed much less than city life. Since the late 1950's, expanded electrical service, improved farming methods, and modern equipment have helped make life easier for Spanish farmers. But

J. Alex Langley, DPI

An Outdoor Market in Barcelona attracts crowds of shoppers seeking fish and other seafood. Spaniards enjoy seafood dishes, and fishing ranks as a leading Spanish industry.

agriculture has fallen far behind industry in economic importance, and rural standards of living are much lower than those in the cities. Since the early 1960's, hundreds of thousands of farmers have moved to Spanish cities or to other countries to find work.

Most farmers live in villages or small towns. Every morning and evening they travel the dirt roads between their homes and the fields, either walking or riding in donkey carts. Unlike city people, they take only a short lunch break. But the evening paseo is as popular in rural areas as in the cities. Rural people also enjoy sitting in their town or village square.

Most rural homes are made of clay and stone, which are covered with whitewashed plaster for added protection from the sun. Most houses have gently sloping tile roofs. Many homes rise directly from the street or from a narrow sidewalk, and many have iron grillwork over the windows.

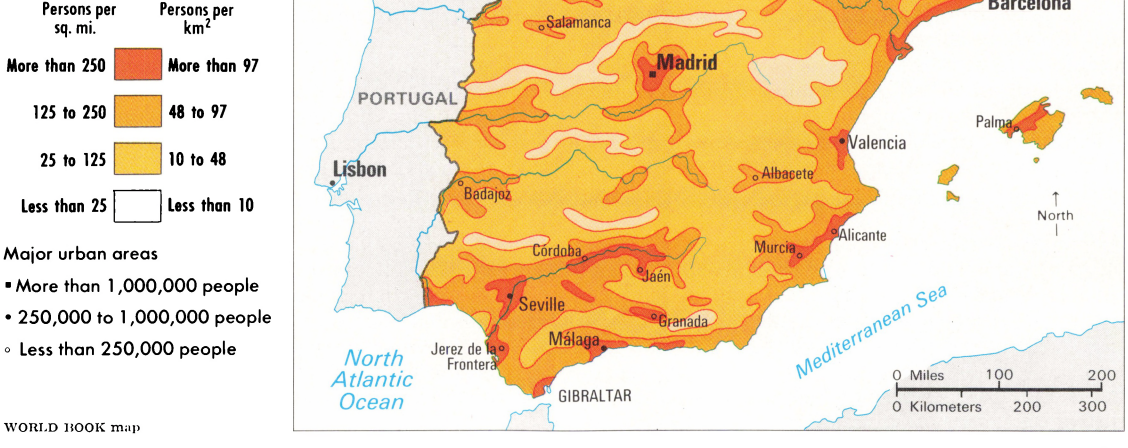
Farmers dress less formally than do city people. Traditionally, the men wear white cotton shirts, black trousers with a sash, and black, round caps called *berets*. The women wear plain dresses or full skirts and blouses.

Food and Drink. Spaniards enjoy seafood, which is inexpensive and plentiful in the coastal waters. They prepare it in a variety of ways. A popular dish is *paella*. It consists of such foods as shrimp, lobster, chicken, ham, and vegetables, all combined with rice that has been cooked with a flavoring called *saffron*. Other favorite dishes include squid, crabs, sardines, and fried baby eels. A popular dish during warm weather is *gazpacho*, a cold soup made of strained tomatoes, olive oil, and spices. It is served sprinkled with bread cubes and chopped cucumbers, onions, and tomatoes.

Popular meats include chicken, goat, lamb, pork,

WHERE THE PEOPLE OF SPAIN LIVE

This map shows the population distribution in Spain and the location of many of Spain's large cities. The most heavily populated areas are shown in the darker colors.



WORLD BOOK map

and rabbit. Beef is too expensive for most Spaniards because the country has little good pastureland for cattle. White bread baked in round or oval loaves is eaten plain or with cheese.

Almost every region of Spain produces wine, and most Spaniards drink wine with all meals except breakfast. They also enjoy a drink called *sangría*, which consists of wine, soda water, fruit juice, and fruit. Other popular beverages include soft drinks, strong black coffee, and thick, hot chocolate, which is usually served with deep-fried strips of dough called *churros*.

Recreation. Spaniards spend much of their leisure time outdoors. They like to sit for hours visiting at sidewalk cafes or in town or village squares. Summer vacations at the country's beautiful beaches have become increasingly popular. On weekends, city people often drive into the countryside for picnics or overnight trips.

Soccer is Spain's most popular sport, and many cities have a soccer stadium that seats 100,000 or more fans. Bullfighting is Spain's best-known and most unusual spectacle. Most cities have at least one bull ring, and leading matadors are national heroes.

Religion. Roman Catholicism is the state religion in Spain. About 99 per cent of the people consider themselves Catholics. But many Spaniards do not attend church, and religion has less and less influence over many of the people.

Spain has a *concordat* (agreement) with the pope that guarantees government support of Roman Catholicism. All Spanish schools must offer instruction in Catholicism, and only Catholic marriages are legal. The church also receives financial support from the government. Non-Catholic religious groups may hold public services and own property, but they may not try to win new followers. About 50,000 Protestants and a few thousand Jews live in Spain.

Religious Holidays. The most important Spanish holiday period is Holy Week, celebrated the week before Easter with parades and other special events. Spaniards also hold celebrations called *fallas* to honor their local *patron* (guardian) saint. Many fallas last several days. People decorate the streets, build bonfires, dance and sing, set off fireworks, and hold parades, bullfights, and beauty contests.

One of the best-known fallas is the *fiesta* (festival) of San Fermin, celebrated each July in Pamplona. Bulls are turned loose in the streets as part of the festivities. Young men run ahead of the animals to the bull ring, where they hold amateur bullfights.

Education in Spain has improved greatly since 1900. Today, only about 10 per cent of the people cannot read and write, compared with more than 60 per cent in 1900.

Spanish law requires all children from ages 6 through 13 to attend school. But many children quit school when they reach 14, and the number of students decreases greatly at each successive higher grade.

Students attend primary school for eight years and secondary school for four years. They must take an additional year of special study before entering a university. The government runs most primary and secondary schools. But there are also Roman Catholic schools and nonreligious private schools at the primary and secondary levels. Spain has 18 universities, which are attended by about 300,000 students.

Michael Kuh, Rapho Guillumette

Spanish Children take part in a Roman Catholic festival in Toledo. The children wear their confirmation clothing for the occasion. Almost all Spaniards belong to the Catholic Church.

Museums and Libraries. The Prado in Madrid, Spain's best-known museum, contains one of the world's finest art collections. It features works by such great Spanish painters as Francisco Goya, Bartolomé Murillo, and Diego Velázquez, as well as by many foreign artists. Madrid's other museums include the Museum of the Americas; the National Archaeological Museum; the Royal Armory; and the Army, Navy, and Municipal museums.

Most of Spain's major cities have museums that exhibit art from the surrounding region. The best known of these museums are the Provincial Museum in Seville and the Museum of Catalan Art in Barcelona. In Toledo, the house of the great painter El Greco has been made into a museum that exhibits many of his works.

Spain's largest library, the National Library in Madrid, has more than 3 million volumes. The Municipal Periodical Library of Madrid owns one of the most complete collections of periodicals in the world. Millions of records and important documents of Spanish history are preserved in the Archives of the Indies in Seville; the General Archives of the Kingdom in Simancas, near Valladolid; and the National Historical Archives in Madrid.

SPAIN / *The Arts*

Spain has a rich artistic tradition and has produced some of the world's finest painters and writers. Spanish arts flourished during a golden age in the 1500's and 1600's, when the country ranked among the world's leading powers. Spain's arts then declined somewhat, but a rebirth has occurred during the 1900's.

Literature. The oldest Spanish writings still in existence are *The Poem of the Cid* and *The Play of the Wise Men*. Scholars believe both works date from the 1100's, but they do not know who wrote them. *The Poem of the Cid* describes the deeds of one of Spain's national heroes, El Cid (see CID, THE). Only part of *The Play of the Wise Men* has been preserved. It tells of the visit of the three wise men to the Christ child.

Spanish writers produced some of the country's best-known literature during the golden age. For example, Miguel de Cervantes wrote the novel *Don Quixote*, one of the world's greatest literary works. The playwright Pedro Calderón de la Barca vividly dramatized the dreams and realities of life in his famous play *Life Is a Dream*. Spain's leading writers of the 1900's include the essayists José Ortega y Gasset and Miguel de Unamuno, the playwright Antonio Buero Vallejo, the novelist Camilo José Cela, and the poet Juan Ramón Jiménez. See SPANISH LITERATURE.

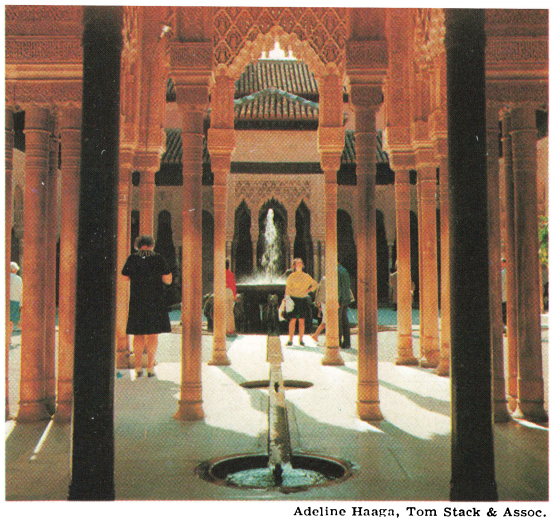
Painting. Spain's leading painters during the golden age included El Greco, Murillo, and Velázquez. Goya, one of the first masters of modern art, painted during the late 1700's and early 1800's.

Spain's best-known artist since 1900 has been Pablo Picasso. He created fine sculptures, drawings, graphics, and ceramics in addition to his paintings. Other leading modern Spanish painters include Salvador Dali, Juan Gris, Joan Miró, and Antonio Tàpies.

Architecture in Spain shows the influence of various peoples who once controlled the country. Some aqueducts, bridges, and other structures built by the ancient Romans are still in use, and the ruins of other Roman structures can be seen throughout the country. *Mosques* (houses of worship) built by the Moors stand in some southern cities, though most of these buildings are now Roman Catholic churches. The enormous cathedral in Córdoba was built as a mosque in the 700's. More than 1,000 pillars of granite, jasper, marble, and onyx support its arches. The Moors also built fortified palaces called *alcazars*. The most famous alcazar is the magnificent Alhambra in Granada (see ALHAMBRA).

Spain has about 1,400 castles and palaces, including the alcazars. El Escorial, a combination burial place, church, monastery, and palace, stands about 30 miles (48 kilometers) northwest of Madrid. It was built in the 1500's and is one of the world's largest buildings. The gray granite structure covers almost 400,000 square feet (37,000 square meters) and has 300 rooms, 88 fountains, and 86 staircases. The tombs of many Spanish monarchs are in El Escorial. See ESCORIAL.

About 10 miles (16 kilometers) from El Escorial is the Valley of the Fallen, another burial place and monastery. It was completed in 1958 after 18 years of work. The burial chamber lies inside a mountain. About 46,000 men who died in the Spanish Civil War are buried there. A cross 500 feet (150 meters) high, cut from a single piece of stone, stands atop the mountain.



Adeline Haaga, Tom Stack & Assoc.

The Alhambra, a famous alcazar in Granada, is known for the beauty of its inner courtyards, such as the Court of the Lions, above. The Alhambra was built during the 1200's and 1300's.

The Gothic cathedral in Seville is Europe's second largest church. Only St. Peter's Church in Rome is larger. The Seville cathedral measures 380 feet (116 meters) long and 250 feet (76 meters) wide, and its tower is 400 feet (120 meters) high. For picture, see CATHEDRAL.

Music. Unlike many other European countries, Spain has produced few leading composers of operas and symphonies. But during the 1600's, Spanish composers created a form of light opera known as *zarzuela*. It combines singing with spoken words. Spain's best-known musicians of the 1900's include the cellist Pablo Casals, the composer Manuel de Falla, and the classical guitarist Andrés Segovia.

Folk singing and dancing have long been popular in Spain, and the people of each region have their own special songs and dances. Musicians provide accompaniment on castanets, guitars, and tambourines. Such Spanish dances as the bolero, fandango, and flamenco have become world famous.

M. Boigne, Rapho Guillumette

The Flamenco, above, is one of the many lively Spanish folk dances. Flamenco dancers are usually accompanied by guitarists.

Spain is the third largest country in Europe. Only France and Russia cover a larger area. Spain occupies more than five-sixths of the Iberian Peninsula, which forms the southwestern tip of Europe. The country also includes the nearby Balearic Islands. Mainland Spain and the Balearics form six major land regions: (1) the Meseta, (2) the Northern Mountains, (3) the Ebro Basin, (4) the Coastal Plains, (5) the Guadalquivir Basin, and (6) the Balearic Islands.

The Meseta is a huge, dry plateau that covers most of Spain. It consists mainly of plains broken by hills and low mountains. Higher mountains rise on the north, east, and south. To the west, the Meseta extends into Portugal. Spain's highest peak, 11,411-foot (3,478-meter) Mulhacén, stands in the Sierra Nevada range on the southern edge of the region.

Poor red or yellowish-brown soil that is unsuitable for raising crops covers most of the Meseta. Forests grow on the mountains and hills, but only small, scattered shrubs and flowering plants can be found on most of the plains. Farmers tend flocks of goats and sheep in the hills and mountains.

Most of Spain's major rivers rise in the Meseta. The longest river, the Tagus, flows 626 miles (1,007 kilometers) from the eastern Meseta through Portugal to the Atlantic Ocean. The Guadalquivir flows 400 miles (640 kilometers) from the southern Meseta to the Atlantic.

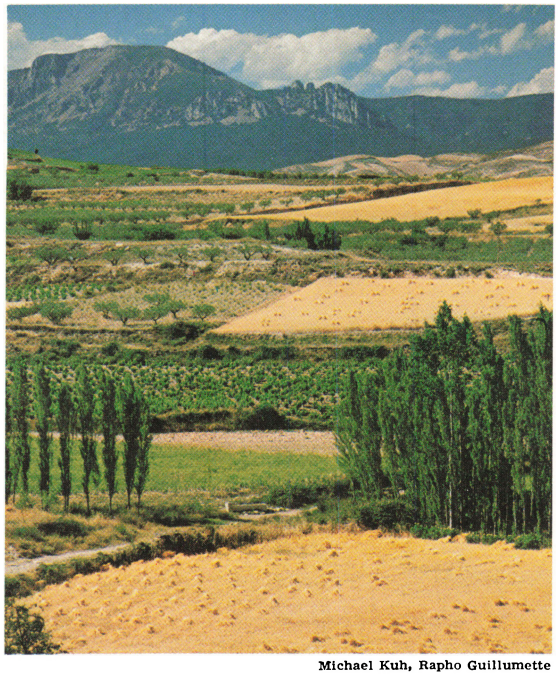
The Northern Mountains extend across northernmost Spain from the Atlantic Ocean to the Coastal Plains. The region consists of the Galician Mountains, in the west; the Cantabrian Mountains, in the central area; and the Pyrenees Mountains, which separate Spain from France, in the east. The Galician and Cantabrian mountains rise sharply from the sea along most of the Atlantic coast. Forests cover many of the slopes in the region, and many short, swift-flowing rivers plunge through the mountains. Like the Meseta, the Northern Mountains have generally poor soil for growing crops, and much of the region is pastureland.

The Ebro Basin consists of broad plains that extend along the Ebro River in northeastern Spain. The Ebro, one of Spain's longest rivers, flows 565 miles (909 kilometers) from the Northern Mountains to the Mediterranean Sea. Its basin is bordered by the Pyrenees to the north, the Meseta to the west and south, and low hills to the east. It is a dry area, but irrigation has turned the basin into an important agricultural region.

The Coastal Plains stretch along Spain's entire Mediterranean coast. The region consists of fertile plains broken by hills that extend to the sea. It is a rich agricultural area. Farmers along the coast, like those in the Ebro Basin, have used rivers that cut through the plains to build irrigation systems.

The Guadalquivir Basin lies in southwestern Spain. It spreads out along the Guadalquivir River to the Atlantic Ocean. The basin is a dry but extremely fertile region in the hottest part of the country. Farmers depend on irrigation to water their crops.

The Balearic Islands lie from about 50 to 150 miles (80 to 240 kilometers) east of mainland Spain in the Mediterranean Sea. Five major islands and many smaller ones make up the group. The three largest islands, in order of size, are Majorca, Minorca, and Ibiza. Majorca is a fertile island with a low mountain range along its northwest coast. Plains stretch from the mountains to hills on the southeast coast. Minorca is mostly flat, with wooded hills in the center. Ibiza is hilly. Both smaller islands are much less fertile than Majorca.

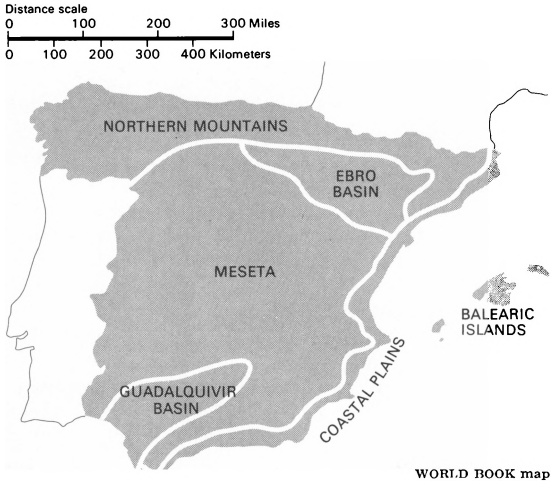


Michael Kuh, Rapho Guillumette

The Meseta is a high plateau that covers most of Spain. Many hills and low mountains rise from the dry plains that stretch across most of the region.

LAND REGIONS OF SPAIN

Spain has six land regions: Northern Mountains, Ebro Basin, Meseta, Guadalquivir Basin, Coastal Plains, and Balearic Islands.



WORLD BOOK map

Peter Menzel, Stock, Boston

The Snow-Capped Pyrenees Mountains, *above,* which form the eastern end of the Northern Mountains region, separate Spain from France. Villages and small towns lie scattered through the rugged, thinly populated Pyrenees.

Physical Features

Agueda R. .....A 2
Alcanadre R. .....A 3
Alcántara Reservoir B 2
Aragón R. .....A 3
Arga R. .....A 3
Bay of Biscay .....A 3
Cabriel R. .....B 3
Cape Creus .....A 4
Cape de Gata .....B 3
Cape Finisterre .....A 1
Cape Nao .....B 4
Cape Ortegal .....A 1
Cape Palos .....B 3
Cape Peñas .....A 2
Cape Tortosa .....A 4
Carrión R. .....A 2
Cega R. .....A 2
Cordillera Cantábrica (Mts.) A 2
Duero (Douro) R. .A 2
Ebro R. .....A 3
El Teleno (Mt.) ....A 2
Gallego R. .....A 3
Genil R. .....B 2
Gibraltar, Strait of B 2
Giguela R. .....B 3
Guadalope R. .....A 3
Guadalquivir R. ...B 2
Guadiana R. .....B 2
Gulf of Almería ....B 3
Gulf of Cadiz .....B 1
Gulf of Mazarron ..B 3
Gulf of San Jorge ..A 4
Gulf of Valencia ...B 4
Ibiza (I.) .....B 4
Jabalón R. .....B 3
Jalón R. .....A 3
Jarama R. .....A 3
Jiloca R. .....A 3
Júcar R. .....B 3
La Mancha (Plain) B 3
La Sagra (Mt.) ....B 3
Las Marismas (Marshes) .....B 2
Luna R. .....A 2
Majorca (I.) .....B 4
Mar Menor (Lagoon) .....B 3
Miño R. .....A 1
Minorca (I.) .....B 4
Moncayo (Mt.) ....A 3
Montes de Toledo (Mts.) .....B 2
Montes Universales (Mts.) .....A 3
Mulhacén (Mt.) ....B 3
Navia R. .....A 2
Odiel R. .....B 2
Peñalara (Mt.) .....A 3
Perdido (Mt.) .....A 3
Pico de Aneto (Peak) .....A 3
Pisuerga R. .....A 2
Pyrenees (Mts.) ....A 4
Sangonera R. .....B 3
Segre R. .....A 4
Segura R. .....B 3
Sierra de Gata (Mts.) .....A 2
Sierra de Gredos (Mts.) .....A 2
Sierra de Guadalupe (Mts.) B 2
Sierra de Guadarrama (Mts.) ..A 3
Sierra de Gúdar (Mts.) .....A 3
Sierra Morena (Mts.) .....B 2
Sierra Nevada (Mts.) B 3
Sil R. .....A 2
Tajo Reservoir .....B 2
Tajo (Tagus) R. ..B 2
Ter R. .....A 4
Tiétar R. .....B 2
Tórmes R. .....A 2
Turia R. .....B 3
Ulla R. .....A 1

Specially created for **World Book Encyclopedia** by Rand McNally and World Book editors

J. Alex Langley, DPI

Spain's Sunny Mediterranean Coast has many resort areas, such as the Costa Brava, above, that attract millions of vacationists each summer. Almost all Spain has hot, dry summers.

The Meseta and other inland regions of Spain have dry, sunny weather throughout the year. These regions, which make up most of Spain, have hot summers and cold winters. The average temperature rises above 80° F. (27° C) during July, the hottest month. It falls below 30° F. (−1° C) in January, the coldest month. Summer and winter droughts—broken only by occasional rainstorms—are common, and steady winds often whip up the dry soil. Upper mountain slopes in the Meseta have snow most of the winter.

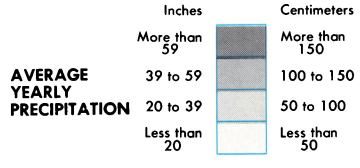
Mild, rainy winters alternate with hot, dry, sunny summers in the Coastal Plains and the Balearic Islands. The average January temperature rarely falls below 40° F. (4° C), and the average July temperature usually rises to almost 80° F. (27° C). Short, heavy rainstorms are common in winter. But summer droughts last up to three months in some areas. The dry, sunny summers attract millions of vacationists each year to the Balearic Islands and to the Costa Brava, Costa del Sol, and other famous resort areas along Spain's Mediterranean coast.

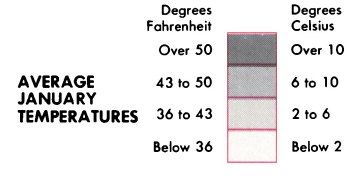
Winds from the Atlantic Ocean bring mild, wet weather to the Northern Mountains in all seasons. The region has Spain's heaviest *precipitation* (rain, snow, and other forms of moisture). Rain falls much of the time throughout the year, usually in a steady drizzle. There are many cloudy, humid days, and fog and mist often roll in from the sea. The region's heaviest precipitation comes in winter, when the upper mountain ranges usually build up deep snow. In January, the average temperature throughout most of the region rarely falls below 40° F. (4° C), and the average July temperature seldom rises above 70° F. (21° C).

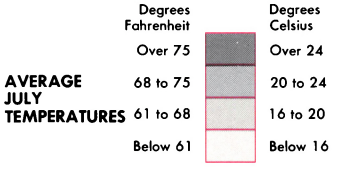
AVERAGE MONTHLY WEATHER

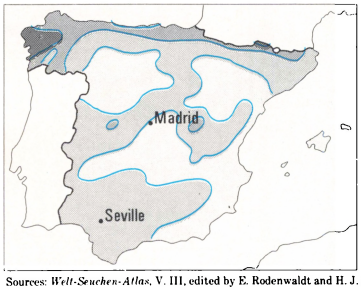
MADRID	Temperatures F° High	Temperatures F° Low	Temperatures C° High	Temperatures C° Low	Days of Rain or Snow
JAN	57	24	14	-4	9
FEB.	61	27	16	-3	9
MAR.	68	30	20	-1	11
APR.	76	34	24	1	9
MAY	84	40	29	4	9
JUNE	91	47	33	8	6
JULY	96	53	36	12	3
AUG.	96	54	36	12	2
SEPT.	89	45	32	7	6
OCT.	77	37	25	3	8
NOV.	63	30	17	-1	10
DEC.	57	25	14	-4	9

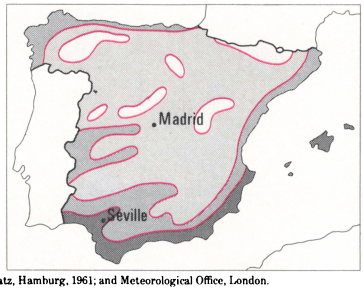
SEVILLE	Temperatures F° High	Temperatures F° Low	Temperatures C° High	Temperatures C° Low	Days of Rain or Snow
JAN.	67	35	19	2	8
FEB.	71	35	22	2	9
MAR.	77	39	25	4	9
APR.	84	43	29	6	8
MAY	94	48	34	9	5
JUNE	101	55	38	13	2
JULY	107	60	42	16	0
AUG.	107	61	42	16	0
SEPT.	101	56	38	13	3
OCT.	91	48	33	9	5
NOV.	76	39	24	4	9
DEC.	68	34	20	1	8

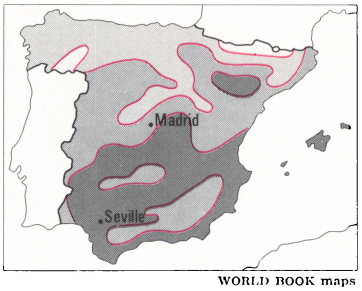












Sources: *Welt-Seuchen-Atlas*, V. III, edited by E. Rodenwaldt and H. J. Jusatz, Hamburg, 1961; and Meteorological Office, London.

WORLD BOOK maps

During the 1950's and 1960's, Spain changed from a poor agricultural country into a modern industrial nation. During this period, the country enjoyed one of the world's highest rates of economic growth as its annual production of goods and services more than tripled. Much of this growth resulted from heavy foreign investment in Spain's industries and from a booming tourist trade.

Between 1950 and 1970, the percentage of Spain's workers engaged in agriculture fell from about 50 per cent to about 30 per cent. At the same time, the percentage of workers employed in the construction, manufacturing, and mining industries rose from about 25 to 37 per cent. Employment in services, which includes such fields as communication, government, and trade, increased from about 25 to 33 per cent.

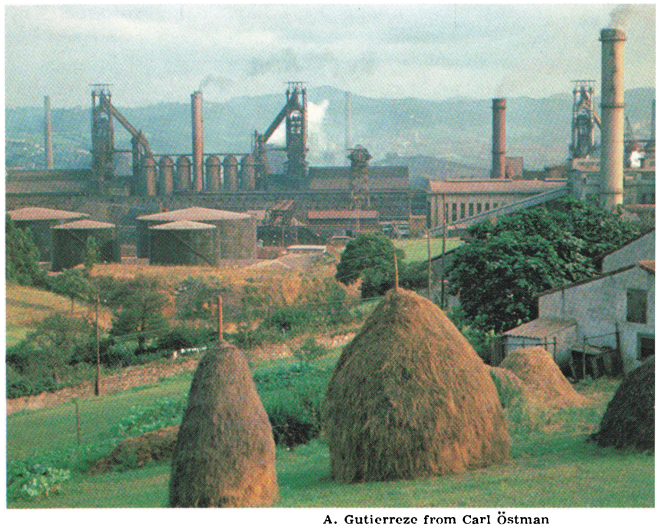
By 1970, the value of yearly industrial production in Spain was more than $2\frac{1}{2}$ times that of agricultural production. Although the country had not become a major industrial power, it was no longer a poor, economically backward nation.

Natural Resources. Spain is poor in natural resources. The country has little good farmland, and it lacks many important industrial raw materials.

Spain's most important mineral resource is the high-grade iron ore found in the Cantabrian Mountains. These mountains also contain coal, but the deposits are mostly of low quality. Other minerals found in Spain include copper, lead, manganese, mercury, potash, pyrites, salt, titanium, uranium, and zinc.

Most of Spain has poor soil and limited rainfall, which make it difficult to raise crops. Thick forests once covered much of Spain, but most of the trees have been cut down through the years. Today, few areas of the country have forests.

Manufacturing. Spain ranks among the world's leading producers of automobiles and ships. Other important manufactured products include cement, chemical products, shoes and other clothing, and steel. Most of Spain's factories are in the northern provinces, and Barcelona, Bilbao, and Madrid are the country's chief industrial centers. The government controls much of the production in the automobile, steel, and certain other major industries. But most factories in Spain are privately owned and operated.



A. Gutierreze from Carl Östman

Spanish Steel Mills, such as this one in northern Spain, supply the nation's automobile, shipbuilding, and other important industries. Spain's steel production has increased greatly since the 1950's as part of the rapid industrial growth in the country.

Many problems threaten the continued growth of Spanish manufacturing. For example, the country's limited natural resources force industrialists to import many raw materials, which raises manufacturing costs. Also, the great majority of factories in Spain are small, employing fewer than 50 workers. Many of these firms use old-fashioned equipment and manufacturing methods, and most of them cannot afford research and development programs. As a result, Spain lags behind other industrial nations in technical development, and manufacturers must hire foreign engineers, scientists, and technicians.

Another problem Spanish manufacturers have is their dependence on investment from outside Spain. Such investment increased more than 500 per cent during the 1960's. Companies and individuals in other countries have been attracted by the low labor costs, low tax rates, and other favorable conditions for investment in Spanish industries.

Agriculture. Almost all the land in Spain is used for farming, either as cropland or as pastureland. But agricultural production in most regions has always been low because of the poor soil, dry climate, and inferior Spanish farming methods. The country does not produce enough food for its people, and so it must import large quantities every year.

Spain's chief farm products are olives, oranges, wheat, and wine grapes. Other important products include barley, cork, corn, lemons, oats, rye, and wool. The

PHOTRI

Olive Orchards are cultivated in the southern Meseta, *above,* and many other regions of Spain. Olives are an important Spanish product, and Spain ranks as a leading olive-growing country.

country ranks among the world's leading producers of cork, lemons, olives, oranges, and wine. Grain crops are grown mainly in Spain's northern regions. Farmers in the south and east produce most of the country's grapes, olives, and oranges and other citrus fruits. Sheep are the chief livestock in Spain. Other important farm animals include beef cattle, chickens, goats, and pigs.

About two-thirds of all Spanish farmers own their farms. The rest work as hired hands or tenants on large farms. Less than 1 per cent of all landowners hold about 50 per cent of the farmland in Spain. The poorest 50 per cent of the landowners own only about 5 per cent of the farmland. Small farmers own most of the farmland in the north. In the south, wealthy landlords hold most of the land.

Since about 1960, the government has introduced modern methods and equipment to more and more Spanish farmers. For example, the total area of irrigated farmland increased by a third during the 1960's, and the number of tractors multiplied more than 4 times. Such advances have increased farm production. But agriculture remains the weakest part of Spain's economy, and it lags far behind farming in most other European countries.

Tourism plays an important role in Spain's economy. The tourist industry employs about a tenth of all Spanish workers, and Spain earns more than $2\frac{1}{2}$ billion a year from its tourist trade.

The number of visitors to Spain has increased rapidly —from about 6 million in 1960 to more than 25 million a year in the early 1970's. The Spanish government has encouraged the growth of tourism, and it operates schools that train hotel managers, tour guides, chefs, and other persons involved in the tourist business. The government also closely supervises the quality of services offered tourists.

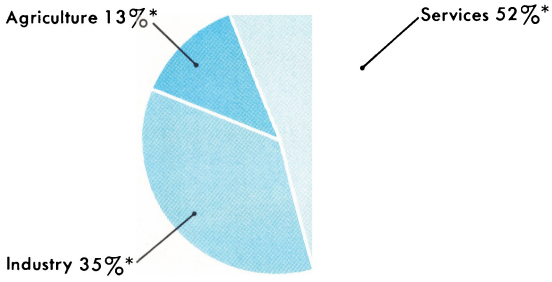
Most of Spain's visitors come from France, Portugal, West Germany, Great Britain, and the United States. They are drawn to Spain by its resorts on the warm, sunny Mediterranean coast and by its bullfights, castles, and colorful festivals. They are also attracted by prices in Spain, which are lower than in most other countries of Western Europe or in the United States.

Fishing. Spain ranks among the leading fishing countries. Its fishermen catch more than $1\frac{1}{2}$ million short tons (1.4 million metric tons) of fish a year, chiefly anchovies, codfish, and hake. Much of the catch comes from the waters off Spain's north coast.

Mining. Spain has a wide variety of mineral resources. But the country has only small deposits of most minerals, and mining has steadily declined in importance during the 1900's.

SPAIN'S GROSS NATIONAL PRODUCT

Total gross national product in 1971—$38,740,000,000



The gross national product (GNP) of a country is the total value of all goods and services produced by the country in a year. The GNP measures a nation's total annual economic performance. It can also be used to compare the economic output and growth of countries.

J. Ciganovic from Madeline Grimoldi

Oranges, an important Spanish product, are packed in crates for shipment to markets in Spain and many other countries. The orange crop comes mostly from southern and eastern Spain.

PRODUCTION AND WORKERS BY ECONOMIC ACTIVITIES

Economic Activities	Per Cent of GNP Produced*	Labor Force*	
		Number of Persons	Per Cent of Total
Manufacturing	27	3,437,800	27
Community, Social, & Personal Services	16	2,242,500	17
Agriculture, Forestry, & Fishing	13	3,706,300	29
Trade	12	1,388,300	11
Government	8	†	†
Transportation & Communication	7	648,700	5
Construction	5	1,096,300	9
Banking, Insurance, & Real Estate	5	†	†
Housing	4	†	†
Utilities	2	91,600	1
Mining	1	120,700	1
Total	100	12,732,200	100

*1970, latest information available.
†Included with Community, Social, & Personal Services.
Sources: Chancellor of the Exchequer and Accounts, Spain; National Institute of Statistics, Spain.

Spain is one of the world's leading producers of mercury. The next most important minerals produced in Spain are coal, iron ore, pyrites, titanium, and uranium. The country also mines copper, lead, manganese, potash, salt, and zinc.

Electric Power. The production of electricity in Spain has increased greatly since 1950. But the supply has not kept pace with the demands of Spain's rapidly growing industries.

Spanish power stations produce about 68 billion kilowatt-hours of electricity yearly. About half the country's electric power comes from hydroelectric stations. Most of the rest comes from power plants that burn coal or other fuels. Spain has few nuclear power plants, but plans call for the rapid development of such plants and for little increase in the production of electricity from other sources.

Foreign Trade. Spain has always imported more goods than it has exported because of its limited natural resources. This situation worsened during the 1950's and 1960's, when Spain's booming economy demanded more and more imported industrial raw materials and machinery. The nation spends almost $3 billion more each year on imports than it earns on exports. But the income from Spain's tourist business makes up for most of this poor balance of trade.

Spain's chief imports include food products, industrial raw materials, and machinery for industry. Its leading exports are cork, fish, mercury, olives, oranges and other citrus fruits, shoes and other clothing, and wine. The nation's main trading partners are France, Great Britain, Italy, The Netherlands, the United States, and West Germany.

Spain has a special trade agreement with the European Common Market, which is made up of Belgium, Denmark, France, Great Britain, Ireland, Italy, Luxembourg, The Netherlands, and West Germany. The agreement reduces tariffs and other trade barriers between Spain and the Common Market nations.

Transportation. Spain has more than 85,000 miles (137,000 kilometers) of paved highway. Spaniards own about 3 million automobiles. Trucks carry most of the freight transported within the country. The government-owned Iberia Air Lines, Spain's only international airline, flies throughout Spain, to North and South America, and to many Western European cities. Many foreign airlines also serve the country.

More than 12,000 miles (19,300 kilometers) of railroad track crisscross Spain. The government-owned Spanish National Railways operates the railway system and has greatly improved service since the mid-1960's. But railway travel has been declining as more and more Spaniards travel by automobile or airplane.

Spanish ships carry about a third of the freight transported between Spain and other nations. These ships also sail between Spanish ports, carrying about a third of the freight transported within the country. Barcelona and Bilbao are the nation's largest ports.

Communication. The government operates Spain's postal and telegraph services. It also controls all television broadcasting and some of the radio broadcasting in the nation. There are more than $8\frac{1}{2}$ million radios and about $4\frac{1}{2}$ million TV sets in Spain. Most homes have a telephone. Spain has about 115 daily newspapers, with a total circulation of about $3\frac{1}{2}$ million copies. The largest daily, Madrid's *A.B.C.*, sells nearly 220,000 copies. More than 3,000 magazines and weekly newspapers are published in the country. Spanish law limits freedom of the press, but press *censorship* (control) has been eased since the mid-1960's.

AGRICULTURE AND INDUSTRY IN SPAIN

Most of the land in Spain is used for farming. The major crops include grapes, olives, oranges, and wheat. Spain's chief mineral resources include coal, iron ore, mercury, and titanium.

WORLD BOOK map

Early Days. More than 100,000 years ago, people lived in what is now Spain. At the beginning of recorded history—about 5,000 years ago—a people known as Iberians occupied much of Spain. They farmed and built villages and towns. Some of these towns, such as Cartagena and what is now Tarragona, developed into the first cities in Spain.

Phoenicians, who lived on the eastern shore of the Mediterranean, began to establish colonies along Spain's east and south coasts in the 1000's B.C. The Phoenicians carried on a flourishing trade with their colonies. Some of the cities they built, such as Cádiz and Málaga, have lasted to the present day.

Celtic peoples moved into Spain from the north about 900 B.C. and again about 600 B.C. They settled in the northern part of the country. Greeks landed in Spain about 600 B.C. and later established trading posts along the east coast.

During the 400's B.C., the powerful northern African city of Carthage conquered much of Spain. Hannibal, the great Carthaginian general, attacked Roman Italy from Spain during the 200's B.C. But the Romans defeated Hannibal in the Second Punic War (218-201 B.C.) and drove all Carthaginian forces from Spain.

Roman Conquest of Spain began during the Second Punic War. But it took the mighty Roman army almost 200 years to conquer the stubborn, freedom-loving Spanish tribes of every region. Rome also conquered what is now Portugal, and so for the first time the entire Iberian Peninsula came under one government. The peninsula became a Roman province called *Hispania*. Spain's name in Spanish, *España*, comes from *Hispania*.

Spain became a leading province of the Roman Empire, and many Romans went there to live. The Romans built cities in Spain and constructed excellent roads to all regions. They also erected huge aqueducts that carried water from rivers to dry areas. Several of Rome's greatest emperors—including Hadrian and Trajan—were born in Spain. Such outstanding Roman authors as Martial and Seneca also came from Spain.

The Romans introduced Latin into the province, and the Spanish language gradually developed from the Latin spoken by Spaniards. Christianity was also introduced into Spain during Roman rule. It became the official religion of the province—and of the Roman Empire—during the late A.D. 300's. About the same time, the empire split into two parts—the East Roman Empire and the West Roman Empire. Spain became part of the West Roman Empire.

Germanic Rule. During the 400's, invading Germanic tribes swept across the West Roman Empire and helped bring about its collapse in 476. One tribe, the Visigoths, invaded Spain and conquered the entire peninsula by 573. The Visigoths set up a monarchy in Spain that was the first separate and independent government to rule the entire peninsula. The Visigoths, who were Christians, tried to establish a civilization like that of the Romans. But continued fighting among the Visigoth nobles and repeated revolts of the nobles against the kings weakened the nation.

Moslem Control. The Visigoths ruled Spain until the early 700's, when Moors from northern Africa invaded the country. The invasion began in 711, and the Moors conquered almost all the Visigoth kingdom by 718. Only the narrow mountainous region across far northern Spain remained free of Moorish rule.

The Moors were Moslems—that is, followers of the religion of Islam—and many of the Spanish people became Moslems as a result of the Moorish rule. The Moslems had a more advanced culture than did most of medieval Europe. The Moslems had made great discoveries in mathematics, medicine, and other fields of study. They had also preserved many of the writings of the ancient Greek, Roman, and Middle Eastern civilizations. In Spain, the Moors made these works available to European scholars. The Moors also constructed many buildings in Spain, including beautiful *mosques* (houses of worship) and fortified palaces called *alcazars*.

The Moorish government of Spain collapsed during the early 1000's because of fighting among groups of Moors. The country then split into many small Moorish states and independent cities.

Reconquest by the Christian Kingdoms. Groups of Visigoths and other Christians in far northern Spain remained independent following the Moorish conquest. These groups formed a series of kingdoms that extended from Spain's northwest coast to the Mediterranean Sea. During the 1000's, these kingdoms began to expand and push the Moors southward.

Castile, in north-central Spain, became the strongest of the growing Christian kingdoms, and its soldiers

Phillip Sheridan, Tom Stack & Assoc.

Ancient Roman Structures can still be seen in many parts of Spain. The Romans controlled Spain for more than 400 years. During that period, they erected many bridges, buildings, and other structures, including the aqueduct in Segovia shown above.

led the fight against the Moors. A Castilian called El Cid, one of Spain's national heroes, emerged as the champion of the Christian cause (see CID, THE).

During the 1100's, several Spanish kings set up a *Cortes* (parliament) to strengthen their support among the people. Each Cortes brought representatives of the middle class, the nobility, and the Roman Catholic Church into the government. But the Spanish kings gave little or no power to the Cortes.

Also during the 1100's, the region that is now northern Portugal gained its independence from Castile. By the mid-1200's, Portugal controlled all its present-day territory. Meanwhile, Spanish Christians continued to fight the Moors. By the late 1200's, the Moslem territory in Spain had been reduced to the Kingdom of Granada in the south. The Christian kingdoms of Aragon, Navarre, and Castile controlled the rest of what is now Spain. Aragon ruled most of eastern Spain and the Balearic Islands. Navarre ruled a small area northwest of Aragon. Castile controlled the rest of Spain. It remained Spain's largest and most powerful kingdom throughout the 1300's and most of the 1400's.

Union of the Spanish Kingdoms. In 1469, Prince Ferdinand of Aragon married Princess Isabella of Castile. Isabella became queen of Castile in 1474, and Ferdinand became king of Aragon in 1479. Almost all of what is now Spain thus came under their rule.

Ferdinand and Isabella wanted to create a strong, united Spain. They considered the Jews and Moslems in Spain to be a threat to this goal. In 1480, the monarchs established the Spanish Inquisition, a special court that imprisoned or killed people suspected of not following Roman Catholic teachings. The Inquisition continued for more than 300 years. Also in the 1480's, Ferdinand and Isabella began to drive the Moslems from Granada. Their troops defeated the Moslems in 1492. That same year, the last of the Spanish Jews who would not convert to Catholicism were killed or driven from the country. Ferdinand seized the small Kingdom of Navarre in 1512 to complete the union of Spain under one monarchy.

The Spanish Empire. In 1492, while working to unify Spain, Ferdinand and Isabella sent Christopher Columbus on the voyage that took him to America. During the next 50 years, Spanish explorers, soldiers, and adventurers flocked to the New World. Vasco Núñez de Balboa crossed Central America in 1513 and became the first European to see the eastern shore of the Pacific Ocean. Hernando Cortes conquered the mighty Aztec nation of Mexico in 1521. In 1533, the huge Inca empire of western South America fell to Francisco Pizarro. These men and other Spaniards explored much of South America and southern North America.

By 1550, Spain controlled Mexico, Central America, nearly all the West Indies, part of what is now the Southwestern United States, and much of western South America. In 1494, Spain and Portugal had agreed to the Line of Demarcation, which divided all South America between them. But they could not secure the entire continent because England, France, and The Netherlands claimed much of it. See LINE OF DEMARCATION.

While its empire grew in America, Spain seized territories in Europe and northern Africa. Spanish troops conquered the southern French province of Rousillon, much of Italy, the Canary Islands, and territory in northern Africa.

In 1516, a grandson of Ferdinand and Isabella became King Charles I of Spain. Charles had ruled the Low Countries (what are now Belgium, Luxembourg, and The Netherlands), and he brought these lands into the Spanish kingdom. Charles was the first in a series of Spanish kings from the Hapsburg family. The Hapsburgs ruled the huge Holy Roman Empire in central Europe. Charles became Holy Roman emperor in 1519. He ruled the empire as Charles V and Spain as Charles I.

The Spanish Empire reached its height during the reign of Charles's son, Philip II, who became king in 1556. In 1580, Portugal was united with Spain. Spain gained control of the Philippine Islands during the late 1500's. Philip's rule brought the beginning of the golden age of Spanish art, when writers and painters created some of Spain's greatest artistic works. His rule also brought the beginning of the end of the empire.

The Spanish Decline began during the 1500's, soon after Spain reached the height of its power. A series of wars drained the royal treasury and weakened Spain's

IMPORTANT DATES IN SPAIN

1000's B.C. The Phoenicians began to colonize Spain.

400's B.C. The Carthaginians conquered much of Spain.

200's B.C. The Romans drove the Carthaginians from Spain.

A.D. 400's Germanic tribes took Spain from the Romans.

711-718 The Moors conquered almost all Spain.

1000's Spain's Christian kingdoms began to drive the Moors from Spain.

1479 The kingdoms of Aragon and Castile united, bringing almost all of what is now Spain under one rule.

1492 Spanish forces conquered Granada, the last center of Moorish control in Spain. Christopher Columbus sailed to America and claimed it for Spain.

1512 King Ferdinand V seized the Kingdom of Navarre, completing the unification of what is now Spain.

1556-1598 The Spanish Empire reached its height—and began to decline—under the reign of Philip II.

1588 The English navy defeated the Spanish Armada.

1808 Napoleon's armies conquered Spain.

1808-1813 English, Portuguese, and Spanish forces drove the French from Spain during the Peninsular War.

1810-1825 All Spain's American colonies except Cuba and Puerto Rico revolted and declared their independence. By this time, Spain had lost almost all its empire.

1898 Spain lost Cuba, Puerto Rico, and the Philippines in the Spanish-American War.

1931 Spain's last king, Alfonso XIII, fled the country, and Spain became a democratic republic.

1936-1939 The Spanish Civil War brought General Francisco Franco to power as dictator of Spain.

1950's and 1960's Spain achieved one of the highest rates of economic growth in the world.

1969 Franco named Prince Juan Carlos, a grandson of Alfonso XIII, as heir to the throne.

1973 Franco named Admiral Luis Carrero Blanco as head of government. Later in the year, Carrero Blanco was assassinated, and Carlos Arias Navarro succeeded him.

armed forces. Bad weather and poor management—as well as heavy spending—ruined the nation's economy. In addition, the people in several Spanish territories revolted.

Philip hoped to reverse Spain's fortunes by conquering England. In 1588, he launched the great Spanish Armada of 130 ships against England. But the English navy and stormy weather destroyed almost half the Armada.

Spain declined further under the weak rulers who followed Philip. It continued to suffer from revolts in its territories, a ruined economy, and frequent warfare with other countries. Portugal declared its independence in the mid-1600's, and France took several of Spain's northeastern provinces.

French forces continued to attack Spain during the late 1600's. To stop the attacks, King Charles II of Spain named a French duke, Philip of Anjou, as heir to the Spanish throne. Charles had no children of his own. He died in 1700, and Philip of Anjou became King Philip V of Spain. Philip was a grandson of France's King Louis XIV and became the first in a series of Spanish rulers from the French Bourbon family.

The succession of Philip V to the Spanish throne touched off the War of the Spanish Succession (1701-1714). France fought England, The Netherlands, and other European nations that opposed French control of the Spanish crown. France lost the war. Under the peace treaty, Philip remained king of Spain, but Spain lost all its possessions in Europe. In addition, Great Britain received Gibraltar and the Balearic island of Minorca. See Succession Wars.

Bourbon Reforms. During the 1700's, the Bourbon rulers of Spain carried out many government reforms. They lowered taxes and collected them more fairly. They also built roads and other public works, and the economy began to grow. Meanwhile, strong ties developed between Spain and France because the rulers of both countries were Bourbons.

Conflict with Great Britain. The 1700's brought Spain into conflict with Great Britain as the two countries challenged each other for colonial power in America. In addition, Spain wanted to regain Gibraltar and Minorca from Britain. As a result of this conflict, Spain became involved with several other European nations in wars with Britain.

Spain also came to the aid of the American Colonies against Britain in the Revolutionary War in America (1775-1783). In 1781, Spanish troops invaded Florida. The Treaty of Paris, which ended the Revolutionary War in 1783, granted Spain control of Florida. It also recognized Spain's control of Minorca, which Spanish troops had taken in 1782. British forces recaptured Minorca in 1798, but Britain returned the island to Spain in 1802.

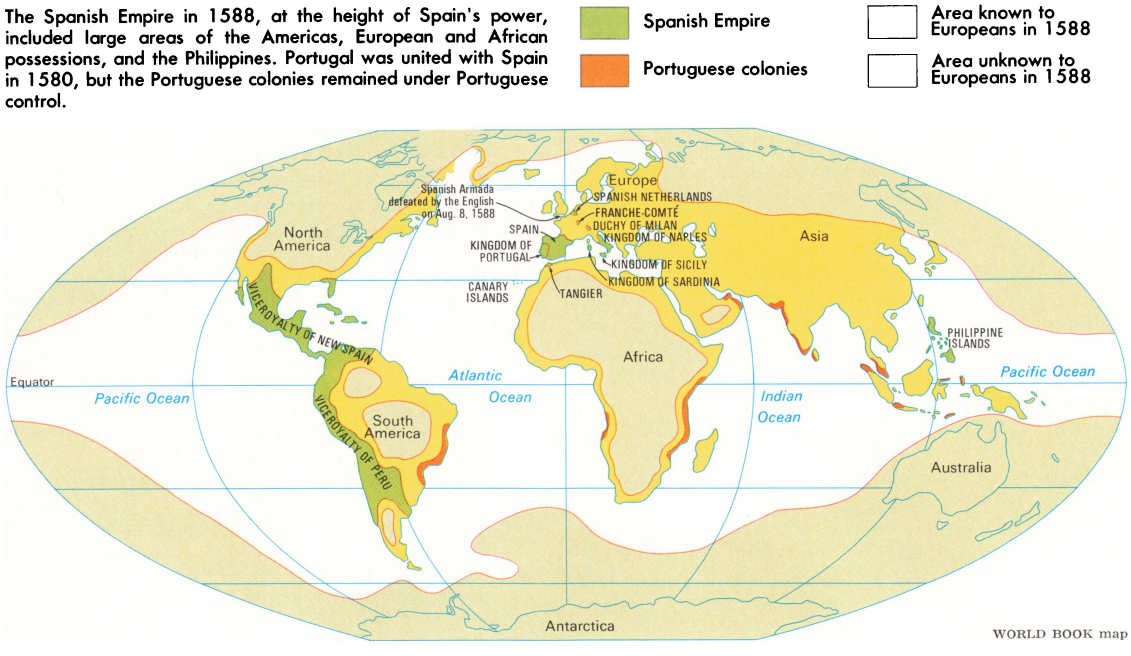
With the addition of Florida, Spain's American empire reached its greatest extent. But the fighting with Britain had weakened Spain.

French Conquest. Napoleon Bonaparte seized control of France in 1799. At first, Napoleon allied France with Spain. But in 1808, French forces invaded Spain and quickly won control of the government. Napoleon forced Ferdinand VII to give up the Spanish throne and named Joseph Bonaparte, his brother, king of Spain.

The Spanish people bitterly resisted the French occupation. They struck back with a hit-and-run method of fighting called the *guerrilla* (little war), a word used ever since to describe such fighting. This opposition led

SPANISH EMPIRE IN 1588

The Spanish Empire in 1588, at the height of Spain's power, included large areas of the Americas, European and African possessions, and the Philippines. Portugal was united with Spain in 1580, but the Portuguese colonies remained under Portuguese control.



Launch of Fireships Against Spanish Armada (about 1588), an oil painting by an unknown artist; National Maritime Museum, Greenwich, England

The Defeat of the Spanish Armada in 1588 marked the end of Spain's reign as the world's most powerful nation. The 130 ships of the Armada sailed against England, and almost half were destroyed. During the fighting, English ships, *right*, launched flaming boats against the Armada, *left*.

to the start of the Peninsular War later in 1808, when Great Britain joined Spain and Portugal against France. The French were driven from the peninsula in 1813.

During the Peninsular War, Spain's Cortes—which had fled from Madrid to southern Spain—drew up a democratic constitution for the country. The new constitution reduced the power of the Roman Catholic Church and increased individual rights and freedoms. But it continued the Spanish monarchy. Supporters of the constitution were known as *liberals*.

Loss of the Empire. King Ferdinand VII returned to the Spanish throne in 1814. He repealed the new constitution and persecuted the liberals. He also tried to regain control of Spain's overseas empire. During the Peninsular War, most of Spain's American colonies had revolted and declared their independence.

In 1820, Spanish troops at Cádiz refused to leave on an expedition to reconquer the American colonies. The mutiny spread quickly into a countrywide military revolt. Ferdinand put down the uprising—with the help of French troops—in 1823. But Spain remained torn politically between Ferdinand's supporters and the liberals. By 1825, Spain had lost all its overseas possessions except Cuba, Puerto Rico, several outposts in Africa, the Philippines, and the island of Guam.

The Reign of Isabella II. In 1833, Ferdinand's daughter succeeded him to the throne as Isabella II. Her reign was opposed by the Carlists, a political group that wanted Ferdinand's oldest brother, Don Carlos, to be king. The liberals supported Isabella. Quarreling among Carlists, liberals, and other political groups created disorder throughout Isabella's reign. In 1868, a group of army officers led a revolt that quickly gained popular support and forced the queen and her family to leave the country.

Six years of political unrest followed the overthrow of Isabella. A republican government was established in 1873, but a civil war broke out between the Carlists and the liberals. The army overthrew the new government in 1874 and, in 1875, brought Isabella's son back to Spain to become King Alfonso XII. He ruled until his death in 1885.

The Reign of Alfonso XIII. Alfonso XII died six months before his son, Alfonso XIII, was born in 1886. Young Alfonso's mother, María Cristina of Austria, ruled in his place until he became old enough to take the throne in 1902.

Spain's most important remaining colonies, Cuba and the Philippines, rebelled in the 1890's. The United States supported Cuba and declared war on Spain in April, 1898. In August, the Spanish-American War ended with Spain's defeat. Spain gave Cuba its independence and surrendered Guam, the Philippines, and Puerto Rico to the United States. All that remained of the once mighty Spanish Empire were a few tiny outposts in northern Africa. See SPANISH-AMERICAN WAR.

During the late 1800's and early 1900's, the power of the Cortes and the prime minister increased. At the same time, Spanish political parties and trade unions gained more and more power. Control of the government alternated between liberals and conservatives, who favored the traditional Spanish way of life. Radicals,

who wanted extreme reforms, and trade union leaders organized continual protests against the government.

Spain remained neutral in World War I (1914-1918) and profited greatly by selling industrial goods to the warring nations. But the war's end caused widespread unemployment in Spain, and Spaniards who had jobs earned low wages. These conditions added to an already growing discontent with Alfonso's rule.

In 1912, Spain gained control over parts of Morocco (see MOROCCO [French and Spanish Control]). But the Moroccans would not submit to Spanish authority. In 1921, they revolted and killed more than 10,000 Spanish troops. This disastrous incident caused bitter disputes in Spain, and these disputes became more intense as the fighting continued in Morocco. Coupled with the nation's political unrest and poor economic conditions, the Moroccan situation led to strikes and violence throughout Spain. In 1923, General Miguel Primo de Rivera headed a military revolt to take over the government and restore order in Spain. Alfonso supported the rebels, and Primo became prime minister with the power of a dictator.

Primo restored order in Morocco and Spain. He also promised to re-establish constitutional government in Spain but repeatedly postponed the move. The army finally turned against Primo in 1930, and he was forced to resign.

Meanwhile, a political movement for a republican form of government gained strength in Spain. The movement consisted of liberals, socialists, and other people who did not want Spain to be a monarchy. Early in 1931, Alfonso called for city elections, to be followed by provincial elections and then a general parliamentary election. In April, the people voted overwhelmingly for republican candidates in the city elections. Alfonso then left the country, though he refused to give up his claim to the throne.

The Spanish Republic. Republican leaders took control of the government after Alfonso left Spain. They called for a parliamentary election to be held in June, 1931. Liberals, socialists, and other republican groups won a huge majority in the Cortes. The new Cortes immediately began work on a democratic constitution, which was approved in December, 1931. That same month, the Cortes elected Niceto Alcalá Zamora, a leading liberal, as the first president of the republic.

The republicans had won control of the government, but political unrest continued in the country. Many Spaniards still favored a monarchy. In addition, the various republican groups were only loosely united. Radical leaders agitated for the overthrow of the government and created uprisings in various sections of the country. The worldwide economic depression of the 1930's added to these difficulties as Spain's exports fell and poverty spread among the people.

The new government reduced the power of the Roman Catholic Church and gave greater power to the trade unions. It took over many of the great estates held by aristocrats and greatly increased the wages of farmworkers. In 1932, the Cortes yielded to demands from nationalists in Catalonia and granted the region limited self-government. Other regions then demanded similar freedom.

The actions of the republican government created opposition among increasing numbers of Spaniards, especially conservatives. The conservatives supported the Roman Catholic Church and wanted Spain to become a monarchy again. The government called for a parliamentary election in 1933. In the election, a newly formed conservative party emerged as the most powerful political force in Spain. This party was the *Confederación Española de Derechos Autónomos* (Spanish Confederation of Autonomous Rights), called the *CEDA*.

Late in 1934, socialists and Catalan nationalists led an uprising against the government. The uprising quickly spread throughout Spain. Government forces put down the revolt, but they killed more than 1,000 persons in the process. The political division in Spain then widened. Army leaders, monarchists, and Roman Catholic groups made up the Right. Communists, socialists, trade unions, and liberal groups formed the Left.

President Alcalá dissolved the Cortes in February, 1936, and called an election to try to unite the republic. Forces of the Left joined in an alliance called the Popular Front and won the election by a slight margin. Their victory touched off increased violence in Spain. Rightists and Leftists fought in the streets. Armed bands dragged opponents from their homes and murdered them. Political assassinations became common.

Civil War. In July, 1936, Spanish army units stationed in Morocco proclaimed a revolution against Spain's government. Most army units in Spain then rose in revolt, and they soon won control of about a third of the country. The rebels hoped to overthrow the government quickly and restore order in Spain. But Popular Front forces took up arms against the military.

In October, the rebel leaders chose General Francisco Franco as their commander in chief. They also made him head of the revolutionary government, called the Council of National Defense. By this time, the revolt had developed into a full-scale civil war. Franco's forces became known as Nationalists or Rebels. They were

THE MONARCHS OF SPAIN

In 1469, Prince Ferdinand of Aragon married Princess Isabella of Castile. The princess became Queen Isabella I* of Castile in 1474. Ferdinand became King Ferdinand II of Aragon in 1479. Most of what is now Spain thus came under the rule of the two monarchs. Isabella died in 1504. By the time Ferdinand died in 1516, he had brought all of what is now Spain under his control as Ferdinand V* of Spain.

Name	Reign	Name	Reign
Charles I (Holy Roman Emperor Charles V*)	1516-1556	Ferdinand VI	1746-1759
		Charles III	1759-1788
		Charles IV	1788-1808
		Ferdinand VII	1808
*Philip II	1556-1598	Joseph Bonaparte	1808-1813
Philip III	1598-1621	Ferdinand VII	1814-1833
Philip IV	1621-1665	Isabella II	1833-1868
Charles II	1665-1700	Amadeo	1870-1873
*Philip V	1700-1724	Alfonso XII	1875-1885
Louis I	1724	*Alfonso XIII	1886-1931
Philip V	1724-1746		

*Has a separate biography in WORLD BOOK.

Wide World

The Spanish Civil War, which lasted from 1936 to 1939, brought General Francisco Franco to power as dictator. Franco's Nationalist forces, shown above advancing along a Madrid street, defeated the supporters of Spain's republican government.

supported by Spain's fascist political party, the *Falange Española* (Spanish Phalanx). The forces that fought to save the republic were called Loyalists or Republicans. Both sides killed civilians and prisoners in a violent, bloody conflict that raged across Spain for nearly three years.

The Spanish Civil War drew international attention. Nazi Germany and Fascist Italy supported Franco's forces, and Communist Russia aided the Loyalists. In addition, Loyalist sympathizers from the United States and many other countries joined the International Brigades formed by Communists to fight in Spain.

By the end of 1937, the Nationalists clearly held the upper hand in Spain. They had taken most of western Spain in the summer of 1936 and were gradually pushing the Loyalist forces to the east and north. Russia ended large-scale aid to the Loyalists in 1938, and Franco launched a mighty offensive against Loyalist armies that same year.

Franco entered Madrid, one of the last Loyalist strongholds, in March, 1939. The remaining Loyalist forces surrendered on April 1. Several hundred thousand Spaniards had died in the war, and much of Spain lay in ruins. A dictatorship under Franco had replaced the short-lived republic.

World War II (1939-1945) broke out five months after the Spanish Civil War ended. Officially, Spain remained neutral in the war. But Franco drew closer to Germany after the fall of France in 1940, when it seemed that Germany would win the war. Late in 1942, however, the tide of war began to turn against Germany. Franco then became friendlier toward Britain, the United States, and other Allied countries.

Involvement in the Cold War. In 1945, Russia launched a campaign calling for international opposition to Franco and for the overthrow of his government. Western nations supported this campaign because of Franco's dictatorial policies and because of his support of Germany and Italy in World War II. Nearly all major countries broke off diplomatic relations with Spain in 1945 and 1946.

In 1947, Franco announced that Spain was still a monarchy and that a king would succeed him upon his death or retirement. Franco hoped this announcement would reduce international criticism of his rule. But it was the growing Cold War—the struggle between Communist and non-Communist nations—that finally led the Western powers to ease their stand against Spain during the late 1940's.

Franco strongly opposed the Communist nations, and the United States sought his help to strengthen the defense of Western Europe. In 1953, Spain and the United States signed a 10-year military and economic agreement. Franco allowed the United States to build military bases in Spain, and the United States gave Spain more than $1 billion in grants and loans. The agreement has been renewed for shorter periods ever since, though U.S. aid to Spain has been greatly reduced.

Growth and Discontent. During the 1950's and 1960's, Spain achieved one of the highest rates of economic growth in the world. The nation's automobile, construction, and steel industries boomed, and the Spanish tourist trade flourished. As a result, the standard of living of most Spaniards rose rapidly.

During the mid-1960's, the government began to ease some of its restrictions on personal freedom. In 1966, for example, the government relaxed its strict censorship of the press. But protests against the government erupted in the late 1960's.

Student demonstrations began in 1968 at the universities of Madrid and Barcelona. The following year, the government closed the universities temporarily. Also in 1968, a Basque organization calling for creation of an independent Basque nation began a terrorist campaign against the government. The Basque disturbances continued into late 1970, when 15 Basques were arrested and convicted of revolutionary activities. Further demonstrations against the government then erupted among supporters of the convicted men. Meanwhile, strikes broke out across Spain among construction workers, miners, and other laborers.

In the mid-1960's, Spain renewed its periodic efforts to regain Gibraltar from Great Britain. In 1965, the United Nations (UN) supported Spain's claim to the territory. But in 1967, the people of Gibraltar voted for continued British control, and Britain decided to keep the colony. Spain closed its border with Gibraltar in 1969, keeping more than 4,500 Spanish workers from their jobs in the colony. Spain also cut telephone links to Gibraltar and sent ships to demonstrate outside Gibraltar Harbor. But Britain would not yield, and

Spain eased its pressures on the colony in 1970.

Spain Today faces two major challenges: (1) the need to continue its rapid economic growth and (2) the need to establish a more democratic and lasting form of government. The Spanish economy continues to expand, but such problems as extreme inflation and a lack of technical development threaten further growth. The government hopes to strengthen the economy with Spain's Third Development Plan, which began in 1972. The plan establishes greater government control of the economy. It also calls for increased housing construction, improved educational programs, and other measures to further raise the people's standard of living.

Strikes and student demonstrations continue to plague Spain, and the people are demanding a greater voice in government. In addition, Spaniards worry about the future of their government after Franco. In 1969, Franco named Prince Juan Carlos as heir to the throne. The prince is a grandson of King Alfonso XIII, who left the country in 1931. In 1973, Franco named Admiral Luis Carrero Blanco as head of government. Blanco was assassinated later that year. Franco then named Interior Minister Carlos Arias Navarro to succeed Blanco. But the future form of Spain's government remained uncertain.

STANLEY G. PAYNE

SPAIN/*Study Aids*

Related Articles. See SPANISH LITERATURE with its list of *Related Articles*. See also:

MONARCHS

See the biographies of the monarchs whose names are marked by an asterisk in the table *The Monarchs of Spain* in this article.

POLITICAL AND MILITARY LEADERS

Alva, Duke of
Franco, Francisco
Gonzalo de Córdoba, Hernández
Jiménez de Cisneros, Francisco
Juan Carlos, Prince
Primo de Rivera, Miguel
Torquemada, Tomás de
Weyler y Nicolau, Valeriano

EXPLORERS AND CONQUERORS

Alvarado, Pedro de
Balboa, Vasco N. de
Cabeza de Vaca, Álvar N.
Columbus, Christopher
Coronado, Francisco V. de
Cortes, Hernando
De Soto, Hernando
Jiménez de Quesada, Gonzalo
Narváez, Pánfilo de
Oñate, Juan de
Orellana, Francisco de
Pizarro (brothers)
Ponce de León, Juan

CITIES

Barcelona
Bilbao
Burgos
Cádiz
Cartagena
Córdoba
Granada
Madrid
Málaga
San Sebastián
Saragossa
Seville
Toledo
Valencia

HISTORY

Aix-la-Chapelle, Treaties of
Armada
Boabdil
Bourbon
Castile and Aragon
Cid, The
Equatorial Guinea
Exploration and Discovery
Falange Española
Granada
Iberia
Inquisition
Line of Demarcation
Loyola, Saint Ignatius
Spanish-American War
Spanish Main
Succession Wars
Trafalgar

PHYSICAL FEATURES

Bay of Biscay
Cape Finisterre
Douro River
Ebro River
Guadalquivir River
Majorca
Mediterranean Sea
Minorca
Pyrenees
Tagus River

PRODUCTS AND INDUSTRY

For Spain's rank among countries in production, see the following articles:

Lemon
Olive
Orange
Ship
Tuna
Wine

REGIONS AND POLITICAL DIVISIONS

Andalusia
Balearic Islands
Canary Islands
Navarre
Spanish Sahara

OTHER RELATED ARTICLES

Alcazar
Alhambra
Andorra
Basque
Bolero
Bullfighting
Castanets
Castle (picture)
Christmas (In Spain)
Cordobés, El
Cork
Doll (picture)
Don Juan
Easter (In Spain)
Escorial
Europe (pictures)
Fiesta
Flag (picture: Historical Flags of the World)
Flamenco
Grandee
Manolete
Montserrat
Peseta
Piaster
Spanish Language

Outline

I. Government
- A. Head of State
- B. President of the Government
- C. Parliament
- D. Local Governmen
- E. Courts
- F. Armed Forces

II. People
- A. Ancestry and Population
- B. Language
- C. City Life
- D. Country Life
- E. Food and Drink
- F. Recreation
- G. Religion
- H. Religious Holidays
- I. Education
- J. Museums and Libraries

III. The Arts
- A. Literature
- B. Painting
- C. Architecture
- D. Music

IV. The Land
- A. The Meseta
- B. The Northern Mountains
- C. The Ebro Basin
- D. The Coastal Plains
- E. The Guadalquivir Basin
- F. The Balearic Islands

V. Climate

VI. Economy
- A. Natural Resources
- B. Manufacturing
- C. Agriculture
- D. Tourism
- E. Fishing
- F. Mining
- G. Electric Power
- H. Foreign Trade
- I. Transportation
- J. Communication

VII. History

Questions

Who were some of the early peoples who lived in what is now Spain?

How does Spain's government promote tourism?

What is the *Meseta?*

What is the weather like in most of Spain?

What is Spain's official form of government?

When was the golden age of Spanish art?

When did Francisco Franco become dictator of Spain?

What is a *falla?* A *paseo?*

When did Spain change from being chiefly an agricultural country into an industrial nation?

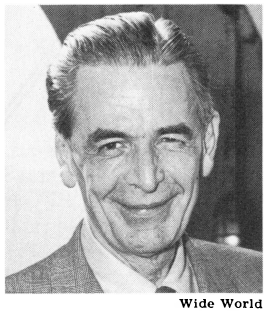
When did the Spanish Empire reach its height? What lands did it include?

Evelyn M. Shafer

The Cocker Spaniel makes a fine companion, and is also an excellent dog for hunting in the field.

SPALATO. See SPLIT.

SPALDING, ALBERT (1888-1953), was an American violinist. His world-wide concert tours were highly successful. He taught violin at the Juilliard Graduate School of Music in New York City. Spalding was born in Chicago. At the age of 7, he began to study violin with Ulpiano Chiti in Florence, Italy. He also studied in Bologna and in Paris, where he made his debut in 1905. DOROTHY DELAY



Wide World

Albert Spalding

SPALDING COLLEGE. See UNIVERSITIES AND COLLEGES (Table).

SPALLANZANI, *SPAHL lahn TSAH nee*, **LAZZARO** (1729-1799), an Italian experimental biologist, showed that the air carries microscopic life. He also showed that microscopic life in food can be killed by boiling. Spallanzani was the first to watch isolated bacterial cells divide. He discovered that bats can dodge strings even when blind, and that salamanders can replace damaged limbs. Spallanzani was born in Scandiano, and took orders in the Roman Catholic Church. He taught at the University of Padua. LORUS J. MILNE and MARGERY MILNE

SPAN. See BRIDGE (The Arch Principle).

SPANIEL, *SPAN yul*, is a large family of dogs. It contains more breeds than any other. The American Kennel Club recognizes 10 spaniel breeds, including the *American water*, *Brittany*, *clumber*, *cocker*, *English cocker*, *English springer*, *field*, *Irish water*, *Sussex*, and *Welsh springer* spaniels. One toy dog, the *English toy spaniel*, may be related to the others. But another toy dog, the *Japanese spaniel*, is probably not related to these spaniels.

The spaniel family probably descended from a Spanish dog, and its name comes from the word *Spain*. All spaniels except the toys are sporting dogs. The spaniel has a gentle and friendly disposition, and likes to hunt in the fields. Spaniels are fine companions as well as good hunters. They make excellent pets. All spaniels except the Brittany have long, silky coats. In general, they have long ears; rather large, round eyes; broad, domed skulls; and sturdy bodies and legs. For a description of the unusual Brittany, see BRITTANY SPANIEL.

All the spaniel breeds except the Brittany hunt game in much the same way. They search the ground within gun range of the hunter. When a spaniel smells game, it rushes in to *flush* it, or make it fly or run. When the game is flushed and the hunter shoots, the spaniel waits for the command, finds the game, and then brings it back to the hunter. MAXWELL RIDDLE

For a list of the separate articles in WORLD BOOK on each spaniel breed, see DOG (table; color pictures: Sporting Dogs).

SPANISH AMERICA is the name sometimes given to the Spanish-speaking parts of Latin America. It includes Central America, except Belize; South America, except Brazil and the Guianas; Mexico; Cuba; Puerto Rico; the Dominican Republic; and certain islands of the West Indies. See also LATIN AMERICA.

SPANISH-AMERICAN WAR

SPANISH-AMERICAN WAR marked the emergence of the United States as a world power. This brief conflict between the United States and Spain took place between April and August, 1898, over the issue of the liberation of Cuba. In the course of the war, the U.S. won Guam, Puerto Rico, and the Philippine Islands.

Background of the War

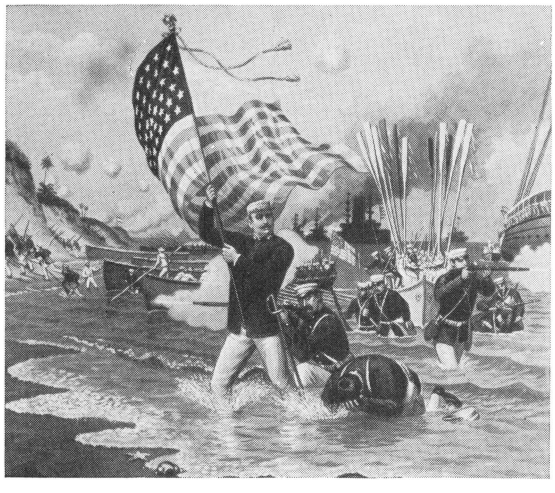
Spanish Misrule. Until about 1860, American expansionists had hoped to acquire Cuba. After the Civil War, interest in annexation dwindled, but Americans continued to be displeased by Spanish misrule. A long and exhausting uprising took place in the 1870's. In 1895, during a depression that made conditions worse, a revolution broke out again and threatened to go on endlessly. The Spanish forces were not powerful enough to put down the insurrection and the rebels were not strong enough to win.

American Intervention. American newspapers, especially the "yellow press" of William Randolph Hearst and Joseph Pulitzer, printed sensational accounts of Spanish oppression, and carried seriously exaggerated reports that a quarter of the population had died. They continually agitated for intervention. Many Americans regarded conditions in Cuba as intolerable and began to demand that the United States intervene. A few felt that the United States should also acquire naval and military bases and become an imperial power.

In November, 1897, President McKinley pressured Spain into granting Cuba limited self-government within the Spanish empire. The rebels wanted nothing less than independence, and continued to fight. Meanwhile, pro-Spanish mobs in Havana rioted in protest against self-government. To protect Americans from the rioters, the battleship *Maine* arrived in Havana harbor January 25, 1898. On February 15, an explosion blew up the ship and killed about 260 persons on board. Although the cause of the explosion was never definitely known, the outraged American public instantly blamed Spain.

The Landing of United States Troops in Cuba during the Spanish-American War is shown in this painting by Joseph Boggs Beale. The fighting men are American Marines.

Joseph Boggs Beale, Modern Enterprise



"Remember the Maine" became a popular slogan, but forces already in operation did more to bring about actual war. In March, President McKinley sent three notes to Spain, demanding full independence for Cuba. Spain granted an armistice. On April 19, Congress passed overwhelmingly a joint resolution asserting that Cuba was independent. The resolution also disavowed any American intention to acquire the island, and authorized the use of the army and navy to force Spanish withdrawal. On April 25, the U.S. formally declared that a state of war existed with Spain as of April 21.

Chief Events

Manila Bay. The first important battle of the war took place in the Philippines. The Asiatic Squadron of six ships under Commodore George Dewey sailed from Hong Kong to Manila Bay. On May 1, 1898, it destroyed the entire Spanish fleet of 10 vessels without the loss of an American life or serious damage to any American ship. Then Dewey blockaded Manila harbor while he waited for U.S. troops to arrive.

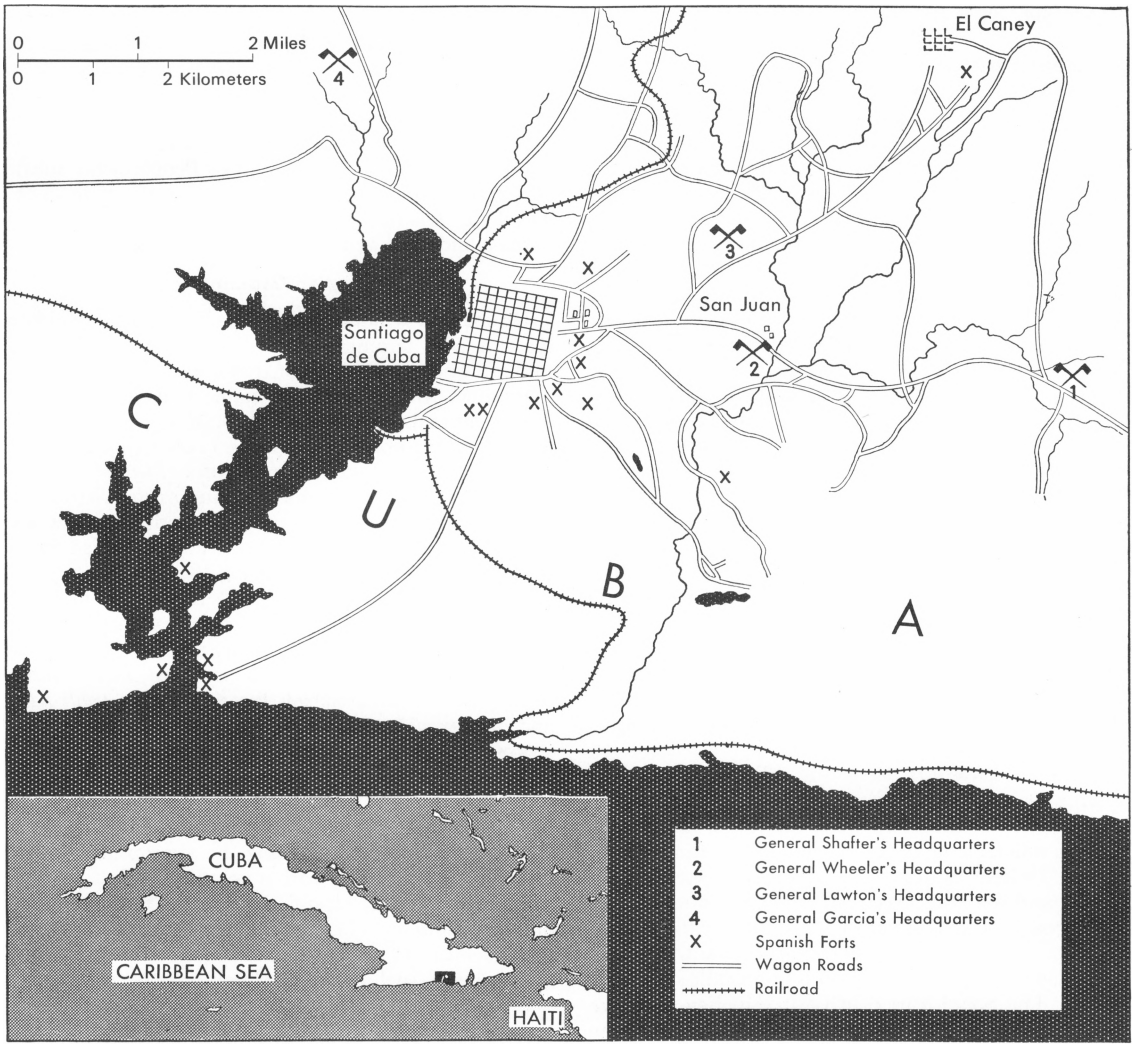
Cuban Blockade. Meanwhile, the North Atlantic Squadron under Rear Admiral William T. Sampson, had begun a partial blockade of Cuba while scouting in the Caribbean Sea for a fleet that had left Spain under Admiral Pascual Cervera y Topete. Finally, on May 28, American ships located Cervera's fleet, which had successfully eluded them and had anchored in the landlocked harbor of Santiago in eastern Cuba. While the navy placed a strong blockading force outside the harbor, the army hastily prepared to send an expeditionary force to assault Santiago by land.

Land Battles. On June 22, Major General William R. Shafter began landing 15,000 troops at Daiquirí and Siboney, near Santiago. The Spaniards offered little resistance during the landing and deploying of troops. Joyful newspaper reports of this helped make celebrities of the Rough Rider Regiment and its commanders, Colonel Leonard Wood and Lieutenant Colonel Theodore Roosevelt.

General Shafter launched a full-scale two-pronged assault against Santiago on July 1. He sent nearly half of his men against a small Spanish force strongly defending a stone fort at El Caney. The remainder made a frontal assault on the main Spanish defenses at Kettle Hill and San Juan Hill. By nightfall, the Americans had taken the ridges commanding Santiago, but they had suffered 1,600 casualties. Both Negro and white Americans fought in the campaign. First Lieutenant John J. Pershing wrote: "White regiments, black regiments . . . fought shoulder to shoulder, unmindful of race or color . . . and mindful only of their common duty as Americans."

As soon as Santiago came under siege, the governor of Cuba ordered Admiral Cervera to run the naval blockade to try to save his ships. Cervera led them out on July 3, heading in single file westward along the Cuban coast. The pursuing American naval vessels, commanded by Commodore Winfield S. Schley, sank or forced the beaching of every one of them. Again no serious damage occurred to any American vessel.

After days of negotiations, Santiago surrendered on July 17. On July 25, Major General Nelson A. Miles began an invasion of Puerto Rico which met almost no opposition. Several contingents of U.S. troops arrived



The Chief Campaign of the Spanish-American War was fought both at sea and on land in the area shown in the detailed map, above. The Americans defeated the Spaniards at El Caney and San Juan, and finally forced their surrender at Santiago. At sea off Santiago, American ships under Commodores Sampson and Schley sank or beached the Spanish fleet under Admiral Cervera. The insert map shows the Santiago region of the larger map in black. The area was backward and disease-ridden.

in the Philippines. On August 13, they entered and occupied Manila, thus keeping the Filipino patriots out. The cables had been cut, and Dewey did not realize that an armistice had been signed the previous day.

Results of the War

The Peace Treaty. Sentiment grew within the United States to keep the spoils of war, except for Cuba. In the Treaty of Paris, signed Dec. 10, 1898, Spain granted Cuba its freedom. Spain ceded Guam, Puerto Rico, and the Philippines to the United States. The United States, in turn, paid Spain $20,000,000 for public property in the Philippine Islands.

Anti-Imperialism. Many people in the United States did not like their nation's new position as a colonial power. These *anti-imperialists* opposed the annexations. They did not wish to hold subject peoples by force, run the risk of becoming involved in further wars, or face competition from colonial products or workers. Their forces were so strong in the Senate that it ratified the peace treaty by only one vote on Feb. 6, 1899.

Other Results. The United States had to put down a long and bloody insurrection in the Philippines, strengthen its defenses, build more powerful battleships, and reorganize the army to remedy serious weaknesses revealed by the war. The war also showed the need for a canal through the isthmus that separated the Caribbean Sea from the Pacific Ocean, and thus led to the building of the Panama Canal.

FRANK FREIDEL

Related Articles in WORLD BOOK include:

Cuba
Dewey, George
Evans, Robley D.
McKinley, William (Spanish-American War)
Maine (ship)
Miles, Nelson A.
Paris, Treaties of
Philippines
Puerto Rico
Roosevelt, Theodore
Sampson, William T.
Schley, Winfield S.
Shafter, William R.
Spanish War Veterans, United
Wood, Leonard

SPANISH ARMADA. See ARMADA.

SPANISH BAYONET is the name of a low, slender yucca tree which grows in the southern United States and in Mexico and the West Indies. It may grow to about 25 feet (8 meters) but usually is much smaller. It has long, flat, bayonetlike leaves, $2\frac{1}{2}$ feet (76 centimeters) long and 2 to 3 inches (5 to 8 centimeters) wide. It bears cream-white flowers, sometimes tinted green or purple. They are about $2\frac{1}{2}$ inches (6 centimeters) wide. Several subspecies have leaves with yellow margins or centers. The flowers, shaped like deep bowls, grow on erect branched stems about 2 feet (61 centimeters) long. See also YUCCA.

Scientific Classification. The Spanish bayonet belongs to the agave family, *Agavaceae*. It is classified as genus *Yucca*, species *Y. aloifolia*. EDMUND C. JAEGER

SPANISH CIVIL WAR. See SPAIN (History).

SPANISH FLY is a beetle, not a true fly. Most Spanish flies live in southern Europe. They are about $\frac{3}{4}$ inch (19 millimeters) long. A substance called *cantharidin* can be extracted from their wing cases. It is used as a *vesicant* (blistering agent) to increase a person's blood circulation and relieve pain.

Scientific Classification. The Spanish fly belongs to the blister beetle family, *Meloidae*. It is genus *Lytta*, species *L. vesicatrix*.

SPANISH INQUISITION. See INQUISITION; TORQUEMADA, TOMÁS DE.

SPANISH LANGUAGE is the official language of Spain and its overseas provinces. It is also the official language of 18 Latin-American republics, and one of the two official tongues of Puerto Rico. Many people in the United States speak Spanish, especially in Florida and the Southwest. Altogether, about 150 million persons speak Spanish, the most widely used Romance language (see ROMANCE LANGUAGE).

The Spanish spoken in Spain is often called *Castilian Spanish*. The Spanish used in Latin America is known as *American Spanish*. Castilian Spanish and American Spanish are basically the same but have a few differences in pronunciation and vocabulary.

Many English words come from Spanish. They include *alfalfa*, *alligator*, *armada*, *cargo*, *cork*, *lariat*, *lasso*, *mosquito*, *potato*, *ranch*, *rodeo*, *tobacco*, *tomato*, *tornado*, and *vanilla*. Some states and many cities in the United States have Spanish names. Among them are *California*, *Florida*, *Nevada*, *Los Angeles*, *San Antonio*, *San Francisco*, and *Santa Fe*.

Spanish Pronunciation

Spanish is one of the most phonetic of all languages. That is, its pronunciation follows its spelling closely. See PHONETICS (The Phonetic Ideal).

Vowels. Spanish has only five basic vowel sounds. These sounds are represented by the letters *a*, *e*, *i* or *y*, *o*, and *u*. The following table gives the approximate English sound for each Spanish vowel:

Spanish Vowel	Approximate Sound in English
a	*a* in *father*
e	*e* in *they*
i or *y*	*i* in *machine*
o	*o* in *owe*
u	*oo* in *moon*

Consonants. Spanish has three consonants not found in English. They are *ch*, *ll*, and *ñ*. Their pronunciation corresponds roughly to the English pronunciation of *ch* in *church*, *lli* in *million*, and *ny* in *canyon*. People who speak American Spanish pronounce the consonants *c* (when it is followed by *e* or *i*) and *z* as English-speaking persons pronounce the *s* in *sink*. People who speak Castilian Spanish pronounce them like the *th* in *think*. The letter *h* is not pronounced in Spanish. The consonants *b* and *v* are generally pronounced the same.

Spanish Grammar

Nouns and Adjectives. All Spanish nouns are either masculine or feminine. Most nouns that name male humans or male animals, or that end in *-o*, *-l*, or *-r*, are masculine. Most nouns that name female humans or female animals, or that end in *-a*, *-d*, or *-ión*, are feminine. For example, *padre* (father), *libro* (book), *papel* (paper), and *calor* (heat) are masculine. *Madre* (mother), *pluma* (pen), *felicidad* (happiness), and *revolución* (revolution) are feminine. Plurals of nouns and adjectives are formed by adding *-s* to those that end in vowels and *-es* to those ending in consonants.

Adjectives must agree in *gender* (masculine or feminine) and in *number* (singular or plural) with the nouns they modify. For this reason, many adjectives have four forms. *Sombrero pequeño* means *small hat*, *casa pequeña* means *small house*, *sombreros pequeños* means *small hats*, and *casas pequeñas* means *small houses*.

Verbs. Spanish has eight simple tenses that are regularly used. They are formed by adding endings to the stem of the verb or to the infinitive. Each simple tense has a corresponding *perfect* (compound) tense. The perfect tenses are formed by using the appropriate simple tense of *haber* (to have) with a past participle.

Spanish verbs are classified according to the endings of their infinitives. They fall into three groups: *-ar* verbs, such as *andar* (to walk); *-er* verbs, such as *correr* (to run); and *-ir* verbs, such as *vivir* (to live).

SPANISH WORDS AND PHRASES

¿adónde va usted? *ah DOHN day VAH oo STAYD*, where are you going?
ayer, *ah YEHR*, yesterday
bien, *BYEHN*, well
bueno, *BWAY noh*, good
buenos días, *BWAY nohs DEE ahs*, good morning
¿cómo está usted? *KOH moheh STAH oo STAYD*, how are you?
¿cómo se llama usted? *KOH moh sayl YAH mah oo STAYD*, what is your name?
gracias, *GRAH syahs*, thanks, thank you
hasta luego, *AH stahl WAY goh*, good-by (until later)
hombre, *OHM bray*, man
hoy, *oi*, today
mañana, *mahn YAH nah*, morning, tomorrow
me llamo Juan, *mayl YAH moh HWAHN*, my name is John
mucho, *MOO choh*, much, a lot
mujer, *moo HEHR*, woman
muy bien, *MWEE BYEHN*, very well
pequeño, *pay KAYN yoh*, small
por favor, *POHR fah BOHR*, please
¿qué hora es? *kay OHR ah EHS*, what time is it?
señor, *sayn YOHR*, sir, Mr.
señora, *sayn YOH rah*, lady, Mrs.
señorita, *sayn yoh REE tah*, young lady, Miss
sí, *SEE*, yes
son las dos, *SOHN lahs DOHS*, it is two o'clock
tengo hambre, *TEHNG go AHM bray*, I am hungry

Word Order in Spanish is similar to that of English. Two exceptions are the positions of object pronouns and descriptive adjectives in Spanish sentences. Object pronouns usually come before the verb in Spanish. In the English sentence *She greeted us*, the verb (*greeted*) comes before the object pronoun (*us*). In Spanish, this sentence becomes *Ella nos saludó* (*She us greeted*). Descriptive adjectives in Spanish usually follow the nouns they modify. In the English sentence *We live in a white house*, the descriptive adjective (*white*) comes before the noun (*house*). In Spanish, this sentence becomes *Vivimos en una casa blanca* (*We live in a house white*).

A Spanish sentence is made negative by placing *no* before the verb. An *interrogative sentence* (one which asks a question) is formed by placing the subject after the verb. A Spanish interrogative sentence has an inverted question mark before the first word, and a regular question mark after the last word. This construction enables readers to recognize an interrogative sentence as soon as they begin reading it. The following are the affirmative, negative, and interrogative forms of the sentence *Charles lives here:* Affirmative—*Carlos vive aquí;* Negative—*Carlos no vive aquí;* Interrogative—*¿Vive Carlos aquí?*

Development

Beginnings. The Spanish language developed from Latin. During the 200's and 100's B.C., Roman armies conquered the *Iberian Peninsula* (present-day Spain and Portugal). The Iberians gradually adopted the language of their conquerors. This language was called *vernacular* (common) Latin. The Iberians changed the language continually. By the A.D. 400's or 500's, vernacular Latin had become Spanish. Few Iberian words remained.

In the early 400's, Germanic tribes invaded the Iberian Peninsula. These tribes controlled the peninsula until 711, but they had little influence on the Spanish language. In 711, the Arabic-speaking Moors conquered all but a small part of the peninsula. They ruled most of the region until the mid-1200's. The Moors added about 700 Arabic words to Spanish. But Spanish remained basically Latin in vocabulary, and changed little in sound and structure.

Castilian Spanish. Like other languages, Spanish developed several dialects. During the 1200's, the Spanish province of Castile became an important literary, military, and political center. The influence of Castile spread, and the Castilian dialect was soon the accepted form of Spanish in most parts of the Iberian Peninsula.

Two other dialects became separate languages during this period. The *Galician-Portuguese* dialect had developed in the western part of the peninsula. This dialect was the basis of the Portuguese language, which began in the 1200's (see PORTUGUESE LANGUAGE). The *Catalan* dialect lived on in northeastern Spain and grew into the Catalan language.

American Spanish. Beginning in the 1500's, Spanish colonists, conquerors, and missionaries brought their language to Latin America. Spanish gradually replaced many Indian languages, including those of the Aztec, Inca, and Maya. Today, Spanish is the official language of all Latin-American republics except Brazil and Haiti.

JOHN A. THOMPSON

See also SPAIN (Language); MEXICO (physical map index [Spanish-English Glossary]).

SPANISH LITERATURE

SPANISH LITERATURE is one of the richest and most varied of all European literatures. The poetry, prose, and drama of Spain are noted for their realism, color, humor, and lyricism.

The geography of Spain helps give special characteristics to the nation's literature. The Pyrenees Mountains and the Mediterranean Sea separate Spain from the rest of Europe. As a result, Spanish writers have kept an individuality somewhat apart from the main currents of European literature. Great rivers and mountain ranges within Spain divide the country into regions. As a result, *regionalism* (concern with a particular area) strongly flavors Spanish literature.

History has also given special features to Spanish literature. The Romans occupied Spain for about 600 years, beginning in the 200's B.C. The main heritage they left to Spain was the Latin language, particularly *vernacular* (spoken) Latin. Vernacular Latin gave birth to three Romance languages that became the most common Spanish dialects—Castilian, Galician-Portuguese, and Catalan (see SPANISH LANGUAGE [Development]). From the A.D. 700's through the 1400's, Christians fought Moslem Moors for control of Spain. This long struggle created a strongly religious patriotism that inspired some of the world's finest religious poetry and prose.

The greatest period of Spanish literature began about the mid-1500's and lasted until the late 1600's. This period, called the Golden Age, brought a flowering of Spanish fiction, poetry, and drama. Spain's greatest and best-known writer, Miguel de Cervantes, the author of *Don Quixote*, lived during this period.

The Middle Ages

Early Medieval Literature. Lyric poetry existed in Spain as early as A.D. 1040. These poems, called *jarchas*, are short refrains added to an Arabic poem called the *muwashaha*. Jarchas were written in Hebrew or Arabic alphabet characters, but the language was a Mozarabic dialect of Spanish (the Mozarabs were Spaniards living under Moslem rule). Jarchas are the oldest form of lyric poetry in a Romance language. Their theme is the sadness of a maiden in the absence of her lover, or simply her longing for love.

Almost all the early Spanish epic poems have been lost. The only one that has survived in nearly complete form is the *Poem of The Cid*, written about 1140. It tells of the adventures of the Castilian hero Rodrigo Díaz. This epic contains stylistic devices similar to those of the *Song of Roland*, a French epic of about 1100. But *The Cid* is more realistic than epics written in other countries during the Middle Ages. It was written only 40 years after the hero's death, so the action of the poem is closer to the actual events that occurred. See CID, THE.

Minstrels called *juglares* who recited epic poems also performed satirical plays called *juegos de escarnio*. Early medieval Spanish drama is not well known. The only play that has survived is a short fragment of a religious

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drama called *The Play of the Wise Men*, from the middle 1100's.

During the 1200's and 1300's, Spanish lyric poetry came under the influence of the poems of the Provençal troubadours of southern France. The early poetry of two related dialects, Galician and Portuguese, was modeled on Provençal poetry. The Galician-Portuguese works, consisting of short *cantigas* (songs) and longer poems, were collected and preserved in three famous medieval *cancioneros* (anthologies). Gonzalo de Berceo was the first Spanish poet known by his name. In the early 1200's, he wrote a series of poems on the *Miracles of Our Lady* in the tradition of other European poets.

The Castilian king Alfonso X, called *the Learned*, helped promote early Spanish prose. In the mid-1200's, he edited the first collection of Castilian laws, *Las Siete Partidas*. Two long historical works were composed under Alfonso's direction—*Crónica General de España*, a history of Spain; and *Grande e General Historia*, a world history. The king also supported the scientific and philosophical interests of the School of Translators of Toledo, which introduced Ptolemy, Aristotle, and other ancient writers to western Europe. In addition, Alfonso is remembered for his Galician cantigas that were dedicated to the Virgin Mary.

The earliest known prose fiction in Spain included a collection of *apologues* (short stories) in Latin. They were collected in 1100 by Pedro Alfonso under the title *Scholar's Guide*. During the 1200's, several series of tales were translated into Spanish from Arabic and other languages. These works included *Calila e Dimna* (1251) and *Sendebar* (1253). In the early 1300's, Spanish prose began to take on a more distinctive character with the writings of Don Juan Manuel, nephew of Alfonso the Learned. Don Juan Manuel wrote many political and historical works. His greatest achievement was *Count Lucanor*, a collection of *exempla* (tales with a moral).

The poetry of the scholars began to decline during the 1300's. Juan Ruiz, archpriest of the town of Hita in Castile, preserved the verse form of the clerics to some extent in his unique and only work, *The Book of Good Love*. This original poetry offers a picture of many details of Spanish life in the 1300's. The poems tell about food, musical instruments, songs, monastic and tavern customs, and love affairs. Ruiz invented the character of Trotaconventos, a go-between of lovers. The poet's elaboration of the fight between Sir Flesh and Lady Lent is the liveliest development of this topic in all medieval literature.

The 1400's. A panoramic view of the lyric poetry of the 1400's appeared in two cancioneros compiled by Juan Alfonso de Baena and Lope de Stúñiga. The Italian poets Dante, Petrarch, and Giovanni Boccaccio influenced the poetry. The spirit of the Middle Ages survived, however, in many anonymous *romances* (ballads). These romances were lyrical fragments of epic songs, and were meant to be sung or recited. They have been preserved through oral tradition in Spain, South America, and Morocco, and among Sephardic Jews.

Three great poets belong to the 1400's: (1) Iñigo López de Mendoza, better known as the Marquis of Santillana; (2) Juan de Mena; and (3) Jorge Manrique. Santillana wrote sonnets in the Italian style, and elaborate, courtly *serranillas* (pastoral poems). He also wrote an important letter about the poetry of the times. Mena wrote *El Laberinto de Fortuna*, an allegorical work of 300 stanzas inspired by Dante and Petrarch. In the second half of the 1400's, Manrique wrote the *Coplas*, an inspired and artistically structured elegy on the death of his father.

Several events of literary importance took place during the late 1400's. Printing was introduced in Spain, probably in Saragossa in 1473. The first book known to have been printed in Spain was dated 1474 in Valencia. In 1492, Antonio de Nebrija published his *Grammar of the Castilian Language*, the first grammar ever written on the rules of a modern European language. The theater took its first steps toward secularization before 1500. Juan del Encina and Lucas Fernández wrote not only Christmas and Easter plays, but also drama with pastoral and folk dialogue. Other new trends in Spanish literature appeared in such novels as Diego de San Pedro's *Cárcel de Amor* (1492) and the Catalan book of chivalry, *Tirant lo Blanch* (1490). The long novel *Amadís de Gaula*, well known since the 1300's, was printed for the first time in 1508. It was probably written by Garci Ordóñez de Montalvo. See AMADÍS OF GAUL.

The masterpiece generally known as *La Celestina* appeared in the late 1400's. It was first published as an anonymous drama in 16 acts under the title *Comedia de Calisto y Melibea* (1499, although there may have been an earlier edition). This great work was later expanded to 21 acts and titled *Tragicomedia de Calisto y Melibea*. The author of at least 15 acts—and probably of the whole work—was Fernando de Rojas. The work was immediately translated into the main European languages. The classic English version became that of James Mabbe (*The Spanish Bawd*, 1631).

The central character of the famous drama is Celestina, a witchlike go-between who brings together two lovers, Calisto and Melibea. The drama combines medieval theology with a Renaissance conception of life. Much of the book's fascination centers on the character of Celestina. The main characters lose their lives one by one. Melibea's father closes the work with a tragic lament that has Biblical overtones. In this lament, he questions even the nothingness of his empty world.

The Golden Age (1500-1681)

The spirit of the Italian Renaissance spread through Spanish literature of the 1500's. Beginning in 1530, literary expression was at constant odds with the Inquisition, an effort by the Roman Catholic Church to punish people who opposed church teachings. Many Spaniards were influenced by the Dutch scholar Erasmus of Rotterdam, who worked for reform of the church. His ideas were clearly present in the philosophical writings of Juan Luis Vives and the brothers Alfonso and Juan de Valdes. The beliefs of Erasmus were even in the work of St. Ignatius Loyola, founder of the Society of Jesus (Jesuits).

Poetry. During the early 1500's, Juan Boscán and Garcilaso de la Vega introduced the meters, verse forms, and themes of Italian Renaissance poetry. The Italian influence soon dominated Spanish poetry. But Cristóbal de Castillejo and Gregorio Silvestre, among others, preserved the Castilian tradition of short lines. Spanish

poetry is indebted not only to such other Spaniards as Hernando de Acuña and Gutierre de Cetina, but also to the Portuguese Francisco Sá de Miranda and Luiz de Camões. Camões' great epic poem *Os Lusíadas* is a masterpiece in the style of Italian epics.

There were two main poetic schools after the mid-1500's—the Castilian school of Salamanca and the Andalusian school of Seville. Poets of both schools wrote in the style of Petrarch. But a certain serenity and a more cautious use of metaphor characterized the school of Salamanca and its representatives—Fray (Brother) Luis de León, Francisco de Figueroa, and Francisco de la Torre. Poets of the school of Seville included Fernando de Herrera, Francisco de Medrano, Francisco de Rioja, Juan de Jáuregui, and Juan de Arguijo. Through the use of colorful images, they developed a refined artistry in the formal possibilities of language that led to the baroque style of the 1600's.

Another important aspect of Spanish poetry of the 1500's was the lyrical expression of mystics—people who seek union with God through constant meditation. Saint John of the Cross was the major mystic poet. Saint Theresa contributed several prose works, including her autobiography, to mystical literature. Two similar writers were Fray Luis de Granada, author of *The Sinners' Guide* (1567), and Fray Luis de León, a professor at the University of Salamanca who was persecuted by the Inquisition. León wrote religious poetry and the prose masterpiece *The Names of Christ* (1583).

Medieval epics survived in the 1500's, not only in the romances but also in books of chivalry. The epic glorification of men and events also continued in long poems by Luis de Zapata, Luis Barahona de Soto, and Bernardo de Balbuena, and in Alonso de Ercilla y Zúñiga's *La Araucana*. This epic poem told of the conflicts between the Indians of Chile and the Spaniards. All these poets wrote in the Italian narrative style.

Prose. The *pastoral novel* became popular among Renaissance writers, and Spanish novelists produced fashionable works that idealized simple, rural life. *La Diana* (1559?) by Jorge de Montemayor and *La Diana enamorada* (1564) by Gaspar Gil Polo are still well-known Spanish pastoral novels. Cervantes in his first work, *La Galatea* (1585), and Lope de Vega in *La Arcadia* (1598) later followed the vogue of pastoral fiction.

The *picaresque novel* was by far the most important contribution of Spanish Golden Age fiction to world literature. This type of novel presented a picture of society as seen through the eyes of a *pícaro* (rogue). The first important picaresque novel was *Lazarillo de Tormes* (1554), written as the short, anonymous autobiography of a young boy of humble and doubtful birth. Lázaro makes his way by cunning and treachery while serving a blind beggar, then a greedy priest, and later a starving squire and other representatives of Spanish society. During his account of his wandering life, Lázaro moralizes on the episodes of his struggle. *Lazarillo* became a famous character and inspired many sequels.

The peak of the picaresque novel was attained by Mateo Alemán with *Guzmán de Alfarache* (first part, 1599; second part, 1604). *Guzmán*, another autobiography of a pícaro, is more detailed than *Lazarillo*. Alemán presented a more bitter, pessimistic view of life by showing that neither human nature nor conditions of life can be changed.

The picaresque novel quickly became a tradition. Vicente Espinel wrote *Marcos de Obregón* (1618). López de Ubeda created a female rogue in *La Pícara Justina* (1605). The poet and satirist Francisco de Quevedo wrote the aggressive, skeptical, and sad novel *Life of the Swindler* (1626). Quevedo also became famous for his satire *Visions* (1627) and his moral essays on politics and history.

The counterpart of the realism of the picaresque novel was the idealism of Cervantes' masterpiece, *Don Quixote* (part I, 1605; part II, 1615). This story of a country landowner who considers himself a knight is filled with humor and sadness. Cervantes believed in the heroic ideals of his leading character and the dream-reality aspect of human life. But he went beyond his times, and gave his characters and themes a quality that extends beyond Spain to all mankind (see DON QUIXOTE). The writings of Cervantes that were most typical of the period were his dramas. But they failed to please audiences of the time, which favored the works of Lope de Vega.

Drama. The Spanish theater developed slowly during most of the 1500's. In 1517, Bartolomé de Torres Naharro published a collection of plays with a prologue on dramatic theory, *Propalladia*. Gil Vicente of Portugal wrote plays in Spanish—*Don Duardos*, *Amadís de Gaula*, and *La comedia del viudo*. The actor-playwright Lope de Rueda created the *paso*, a short farce that ridiculed the daily life of his time. Juan de la Cueva was the first author to take his plots from Spanish history or from popular narrative songs called ballads.

Lope de Vega emerged in the late 1500's as a unique literary figure of the Golden Age. He wrote for popular audiences, mixing tragic and comic elements. The topics of Lope's dramas had various origins. As the creator of a national drama, he drew on historical events. He also glorified national heroes. Lope filled many of his plays with the greatness of the spirit of the common people. But he also created rulers who had divine attributes and were concerned with justice. Some of Lope's plays were cloak-and-sword comedies, with love and honor the sources of dramatic conflict. Others were light plays with complicated plots in which his qualities of poet and dramatist stand out. The *bobo* (fool) of earlier comedies became a constant character in Lope's plays in the form of the *gracioso*, the witty counterpart of the hero.

Other dramatists of Lope's school included Tirso de Molina, whose *The Deceiver of Seville* (1630) was the first staging of the Don Juan legend; Guillén de Castro; the Mexican-born Juan Ruiz de Alarcón; Lope's biographer, Juan Pérez de Montalván; Francisco de Rojas Zorrilla; and Agustín Moreto.

The 1600's. At the beginning of the 1600's, the world of art sought new forms of expression. Artists tended toward greater ornamentation and complication in their works. The resulting style was called *baroque* (see BAROQUE). In Spain, there were two literary indications of this trend—*conceptismo* and *culteranismo*.

Conceptismo featured a subtle and ambiguous use of figures of speech, including antithesis, parallelism, and metaphor (see FIGURE OF SPEECH). The use of an elaborate metaphor called *concepto* (conceit) was the

best example of this trend. Many works of Quevedo and Baltasar Gracián were also examples.

Luis de Góngora led the culteranismo movement, which later became known as *gongorismo*. Góngora created lyric poetry full of color, imagery, and richness in musical linguistic effects. His long and complex poems *Polifemo and Galatea* (1612) and *Las Soledades* (1613), as well as his sonnets, ballads, and short compositions, became models for new developments in literature. Other poets who cultivated culteranismo included Pedro Soto de Rojas; Juan de Tarsis, the count of Villamediana; Luis de Carrillo y Sotomayor; and Sor (Sister) Juana Inéz de la Cruz, a Mexican nun.

Drama was also influenced by the baroque style. Pedro Calderón de la Barca succeeded Lope de Vega as the leading Spanish dramatist. He was more profound than his predecessor in the creation of character and the presentation of human problems. Calderón dramatized the dreams and realities of life in a singular work, *Life Is a Dream* (1635). The theme of honor and the conflict between love and jealousy were topics frequently staged by Calderón. His historical comedies and religious dramas showed his versatility. Calderón's work was full of examples of the baroque style. But his *autos sacramentales* (religious plays about the Eucharist) reflected culteranismo combined with the spirit of the Counter Reformation. The Counter Reformation was a reform movement within the Roman Catholic Church following the Protestant Reformation. Calderón used symbolism to express in solemn verse philosophical explorations of life and death, original sin, and free will. Calderón's best-known autos included *The Great Theatre of the World* and *The Feast of Belshezzar*.

The 1700's and 1800's

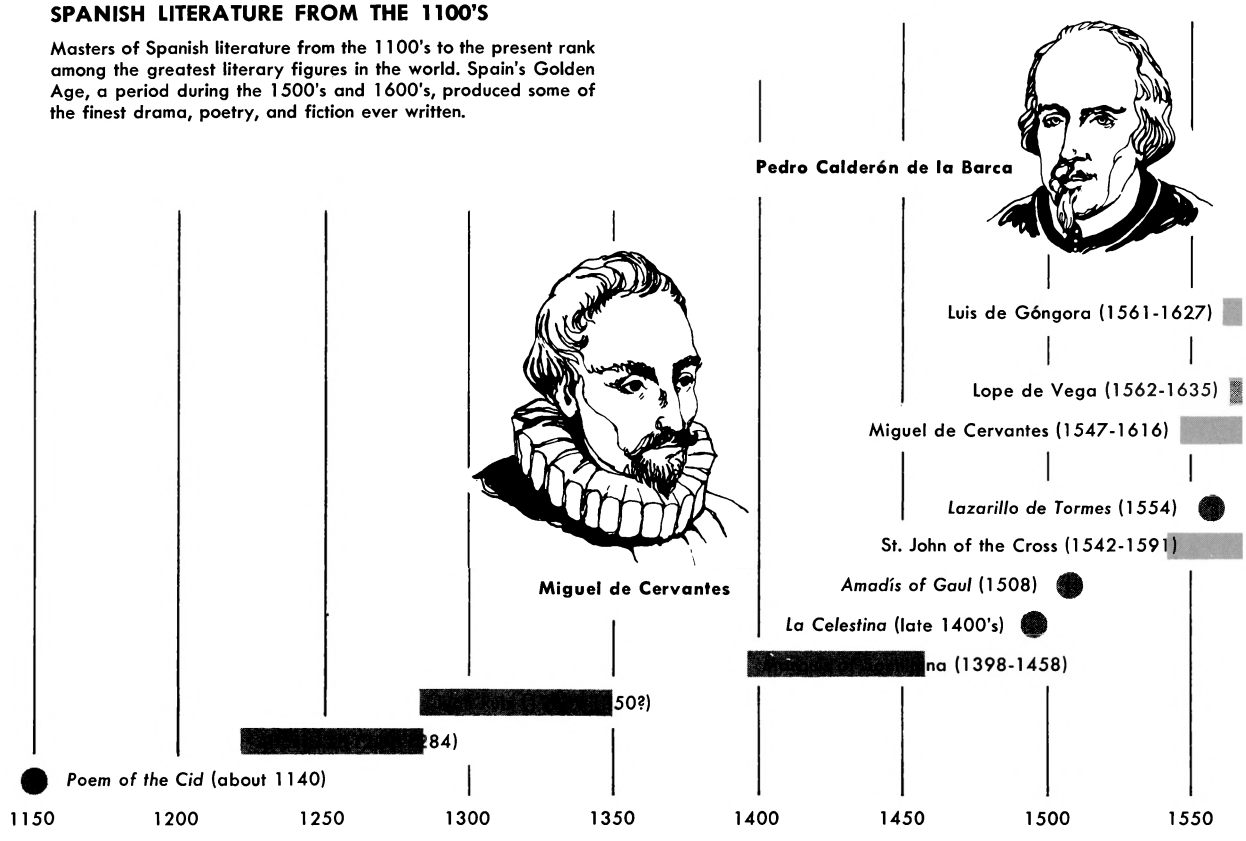
Neoclassicism. By the end of the 1600's, Spain had declined politically, economically, and artistically. Philip V, a Frenchman, became king of Spain in 1700 and began the Bourbon dynasty of rulers. With French rulers in Spain and the beginning of the Age of Reason (Enlightenment) in the rest of Europe, it was inevitable that Spanish literature would assume new directions.

Many writers tried to refine Spanish literature along the lines of French classicism (see CLASSICISM). Benito Jerónimo Feijóo, a Benedictine friar, wrote on almost every branch of learning in his *Teatro Crítico Universal* (8 volumes, 1726-1739) and *Cartas Eruditas y Curiosas* (5 volumes, 1742-1760). Ignacio Luzán also wrote within the framework of the Enlightenment. He supported the new ideas of reason, simplicity, and common sense in his book of literary criticism, *La Poética* (1737). Few Spanish writers of the time wrote novels. The only novel of note was *The History of the famous preacher, Friar Gerund de Campazas* (1758) by the Jesuit José Francisco de Isla. Two of the most important writers in Spain during the 1700's were José Cadalso and Gaspar Melchor de Jovellanos. Cadalso criticized the defects he saw in his countrymen in his best-known collection of essays, *Cartas marruecas* (1789). Jovellanos was a liberal poet, essayist, and economist.

The spirit of the 1700's did not favor lyrical expression. Neoclassicism, a style strongly influenced by Greek and Roman literature, was the most popular trend of the day. However, two of the best poets, Juan

SPANISH LITERATURE FROM THE 1100'S

Masters of Spanish literature from the 1100's to the present rank among the greatest literary figures in the world. Spain's Golden Age, a period during the 1500's and 1600's, produced some of the finest drama, poetry, and fiction ever written.



Meléndez Valdés and Nicasio Álvarez de Cienfuegos, wrote sentimental works under the influence of the French philosopher Jean Jacques Rousseau and other romantics. These poets were examples of a pre-romantic taste becoming prevalent in Spain. Manuel José Quintana clearly belonged to the neoclassical school. His odes and long poems had a patriotic sentiment that reflected ideas more than emotions. The works of Juan Nicasio Gallego resembled those of Quintana.

Romanticism came late to Spain. It was mainly a response to the more intense romantic impulses in the rest of Europe, and represented little more than a literary fashion (see ROMANTICISM). Spanish liberals brought the new philosophy of art and life with them when they returned from exile in the 1830's after the death of Ferdinand VII.

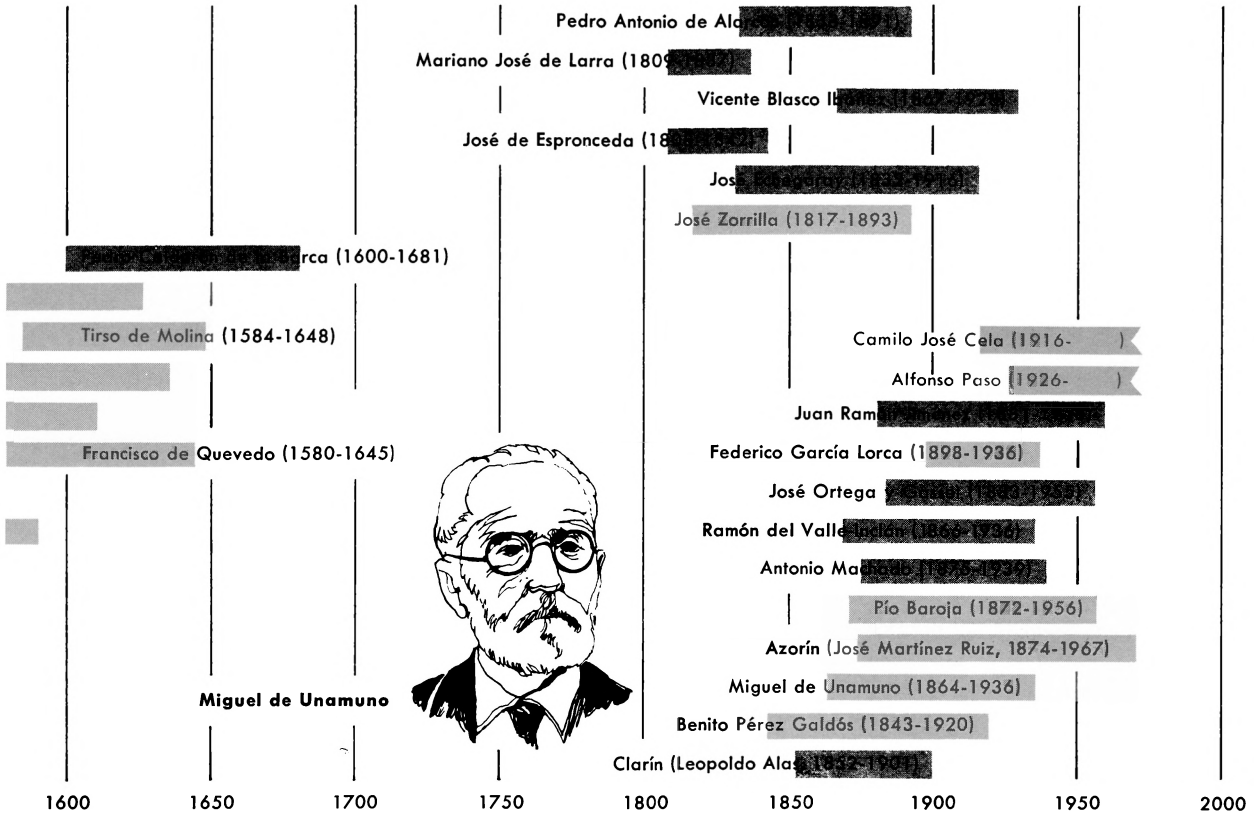
Ángel de Saavedra, the Duke of Rivas, assured the success of the romantic theater when he staged his drama *Don Álvaro, o La fuerza del sino* in 1835. Antonio García Gutiérrez pleased the public with *El Trovador* (1836). Juan Eugenio Hartzenbusch and Francisco Martínez de la Rosa also wrote for audiences that enjoyed romanticism. The peak of the romantic theater was reached by José Zorrilla. In 1844, he revived the Don Juan myth in *Don Juan Tenorio*, one of the long-lasting successes of the Spanish stage. Manuel Tamayo y Baus showed the influence of the high passion typical of romanticism in his historical tragedy *The Madness of Love* (1855) and in *Un drama nuevo* (1867). Manuel Bretón de los Herreros wrote satirical, realistic comedies. Adelardo López de Ayala took his plots from the life of the Spanish middle class. In the late 1800's, romanticism returned in the dramas of José Echegaray, who received the 1904 Nobel prize for literature. His best-known work was *The Great Galeoto* (1881). A concern for social justice, obvious in *Juan José* (1895) by Joaquín Dicenta, highlighted the Spanish stage in the late 1800's.

Spain's most distinguished poets of the 1800's were José de Espronceda and Gustavo Adolfo Bécquer. Espronceda's long poems *El Diablo Mundo* (1841) and *El estudiante de Salamanca* (on the Don Juan theme) included the richest expression of vibrant Spanish romantic poetry. Bécquer could be called the last of the romantics, but he lived when romanticism as a literary school was already outdated. His collection *Rimas* (1871) shows he was the most sensitive poet of the 1800's.

Two poets, Ramón de Campoamor and Gaspar Núñez de Arce, represented a reaction to romantic sentimentality. Campoamor composed short poems which were philosophical and skeptical. He called them *doloras* and *humoradas*. Núñez de Arce expressed an aggressive patriotism in *Gritos del combate* (1875). Rosalía de Castro wrote delicate lyrics, and her one book in Castilian made her one of the most respected poets of the 1800's.

Romanticism in Catalonia led to a revival of literature in the Catalan language during the last half of the 1800's. It produced such excellent poets as Jacinto Verdaguer and Juan Maragall, and such dramatists as Ángel Guimerá.

Short prose sketches of regional customs and manners developed from romantic literature picturing regional customs and folklore. This type of literature was called *costumbrismo*. Writers who created costumbrista articles



included Serafín Estébanez Calderón, known as *El Solitario*. He described typical scenes and people from the province of Andalusia in articles published as *Escenas andaluzas* (1847). Ramón de Mesonero Romanos, who called himself *El Curioso Parlante*, wrote articles about Madrid and published them in three volumes, *Panorama Matritense*. Mariano José de Larra, one of the best prose writers of the 1800's, was similar but more romantic in his attitude. His costumbrista articles, written in the tradition of Quevedo and Cadalso, showed deep concern for Spain. In his critical essays and journalism, often violent, he tried to awaken the nation to its possibilities.

The costumbrista articles gave rise to the Spanish realistic novel which developed in the mid-1800's. Cecilia Böhl de Faber, who wrote under the name of Fernán Caballero, brought costumbrismo to the novel in *La gaviota* (1849). Pedro Antonio de Alarcón wrote about Andalusian characters in his charming story *The Three-Cornered Hat* (1874) and in *The Infant with the Globe* (1880). Juan Valera, one of the most cultured writers of the 1800's, wrote *Pepita Jiménez* (1874) and *Juanita la Larga* (1895). These novels, as well as his literary criticism, reflected his worldly and sophisticated spirit.

Realistic regional novels dominated the second half of the 1800's. José Mariá de Pereda's *Sotileza* (1884) and *Peñas arriba* (1895) were costumbrista novels about life on Spain's northern coast. *Marta y María* (1883) by Armando Palacio Valdés dealt with the conflict of mystic and domestic virtues set against the detailed description of an Asturian city. Emilia Pardo Bazán wrote *Los pazos de Ulloa* (1886), a sparkling narrative of local traditions and politics of the interior of Galicia. *The Cabin* (1898) and *Reeds and Mud* (1902) by Vicente Blasco Ibáñez were tragedies of the swampland near Valencia. Ibáñez is also known for his two novels inspired by the terror of World War I, *Los cuatro jinetes del Apolcalipsis* (*The Four Horsemen of the Apocalypse*, 1916) and *Mare Nostrum* (1918).

The famous literary critic Leopoldo Alas, who wrote under the name of Clarín, created perhaps the best Spanish novel of the 1800's—the carefully structured and sensitive *La Regenta* (1885). But Spain's truly great novelist of the 1800's, and probably of the last 300 years, was Benito Pérez Galdós. He wrote 80 novels and 24 plays. In the five series of novels that make up the *Episodios nacionales*, Galdós novelized Spanish history from the Battle of Trafalgar (1805) until 1900. Many of his works were novels of ideas in which he dealt with religion and economics. He created profound characterizations—particularly his main female characters—and showed unusual awareness of the depth of human psychology. Galdós wrote about all levels of society, and his novels provided a clear insight into life in Madrid during the last half of the 1800's. His best novels were *Doña Perfecta* (1876), *El amigo Manso* (1882), *Fortunata y Jacinta* (1886-1887), *Miau* (1888), and *Misericordia* (1897).

The 1900's

The Generation of 1898 was a group of writers who appeared on the literary scene about the time of the Spanish-American War. These writers played an important part in the history of Spanish literature.

In the Spanish-American War, fought in 1898, Spain lost the last parts of its once mighty empire. The corruption of Spain's ruling class and the loss of its overseas colonies led many Spaniards to examine the nation's culture and civilization. The problem was whether Spain's cultural heritage could be adapted to the progress of modern Europe, and if it was original and creative enough to survive. From this examination of the Spanish character and past came a philosophical, historical, and artistic awakening that produced rich artistic expression.

Many types of writers contributed to the national renaissance of creative genius that dominated Spanish letters during the early 1900's. Miguel de Unamuno expressed romantic and existential grief in such essays as *The Tragic Sense of Life* (1912); poetry; and such novels as *Mist* (1914). Unamuno is often considered a forerunner of the philosophical movement called existentialism. The unique prose of *Azorín* (José Martínez Ruiz) included delicate and melancholic descriptions of Spanish landscape and history (*Castilla*, 1912; and *Doña Inés*, 1925). Pío Baroja became the leading Spanish novelist of the early 1900's. He showed sensitive heroes fluctuating between failure and triumph in such works as *The Tree of Knowledge* (1911) and *Zalacaín el aventurero* (1909). The poetry of Antonio Machado portrayed the severe spirit and landscape of Castile. Ramiro de Maeztu expressed himself in biting journalism. The beautiful prose style of Ramón del Valle-Inclán appeared in such novels as *Sonata de otoño* (1902) and *Divinas palabras* (1920). In such *esperpentos* (satires) as *Luces de bohemia* (1924), Valle-Inclán saw Spain as a grotesque distortion of normalcy.

Spain's literary past was rediscovered, interpreted, and edited and published by a group of scholars at the Center of Historical Studies in Madrid. These scholars included Ramón Menéndez Pidal, Américo Castro, Tomás Navarro Tomás, and José Fernandez Montesinos. They continued the work of Marcelino Menéndez y Pelayo, the great scholar and critic of the late 1800's.

Two fine novelists succeeded the Generation of 1898. Gabriel Miró was extremely lyrical, and Ramón Pérez de Ayala was one of the most intellectual novelists of his day. Noted essayists included the Catalan philosopher and art critic Eugenio d'Ors, and the internationally famous philosopher, historian, and critic José Ortega y Gasset. Among Ortega's works were *The Dehumanization of Art* (1925) and *The Revolt of the Masses* (1930). He and Unamuno became the outstanding Spanish intellectuals of the 1900's.

Poetry. While the Generation of 1898 was trying to discover the spirit of Spain, lyric poetry was undergoing the renewals of *modernism*. This school was inspired by the work of the Nicaraguan poet Rubén Darío and the French Symbolists (see LATIN-AMERICAN LITERATURE [Modernism]). The modernists joined the richness of form, musicality, and expression of the Spanish language with new poetic concepts, and created a new wealth of lyric poetry.

The school of modernism was best represented by Manuel Machado and Gregorio Martínez Sierra. Although short-lived, it inspired many poets whose production has been unequaled during the 1900's in qual-

ity and intensity. These writers included Juan Ramón Jiménez, winner of the 1957 Nobel prize for literature.

During the 1920's and 1930's, a number of poets turned to the traditional ballad or to the complex, colorful gongorismo for inspiration. Among those who wrote original and expressive lyric poetry were Pedro Salinas, Jorge Guillén, Léon Felipe, Gerardo Diego, Federico García Lorca, Dámaso Alonso, Vicente Aleixandre, Luis Cernuda, and Rafael Alberti. Lorca was also one of the great playwrights of the 1900's.

In the 1930's, Miguel Hernández, Leopoldo Panero, Luis Rosales, Luis Felipe Vivanco, and Germán Bleiberg represented a return to the formal poetry of the Renaissance. But their works reveal the anguish often present in love poetry. Prose writers of note included Ramón Gómez de la Serna and Benjamín Jarnés.

The Spanish Stage during the early 1900's was dominated by Jacinto Benavente, winner of the Nobel prize for literature in 1922. His plays *Bonds of Interest* (1907) and *The Passion Flower* (1913) received international praise. Two brothers, Serafín and Joaquín Alvarez Quintero, wrote amusing and delightful plays on Andalusian life. The plays of José María Pemán and the verse dramas of Eduardo Marquina dealt patriotically with Spanish national themes. The costumbrista plays of Carlos Arniches and the farces of Pedro Muñoz Seca pleased audiences of the time. The drama of this period reached a peak in the lyrical rural tragedies of Federico García Lorca. His plays included *Blood Wedding* (1933) and *The House of Bernarda Alba* (1936).

Spanish Literature Today. The Spanish Civil War (1936-1939) caused a break in Spanish literature. Some writers were killed and others were exiled, and the world of letters took some time to recover. But then came Camilo José Cela's novel *The Family of Pascual Duarte* (1942), followed by Carmen Laforet's *Nada* (1944) and Cela's *The Hive* (1951).

The 1940's and 1950's were productive, with some pre-Civil War writers still dominating the scene. But the new talent, characterized by social realism, was extraordinary. The novels of Miguel Delibes, Rafael Sánchez Ferlosio, José María Gironella, and Juan Goytisolo won international recognition. The theater was represented by the philosophical plays of Antonio Buero Vallejo and Alfonso Sastre, and the social comedies of Alfonso Paso.

Poetry since 1939 first followed a direction toward simpler forms of expression with Dionisio Ridruejo and José Luis Cano. Then poetry changed to a nonconformist attitude with Gabriel Celaya, Blas de Otero, and such younger writers as Claudio Rodríguez. Some writers, including the novelists Francisco Ayala and Ramón Sender and the playwright Alejandro Casona, developed their work in exile. Julián Marías, José Luis Aranguren, and José M. Ferrater Mora wrote philosophical and social essays. GERMÁN BLEIBERG

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SPANISH SAHARA

Outline

I. The Middle Ages
A. Early Medieval Literature
B. The 1400's
II. The Golden Age (1500-1681)
A. Poetry
B. Prose
C. Drama
D. The 1600's
III. The 1700's and 1800's
A. Neoclassicism
B. Romanticism
IV. The 1900's
A. The Generation of 1898
B. Poetry
C. The Spanish Stage
D. Spanish Literature Today

Questions

What effect did *costumbrismo* have on the novel of the mid-1800's?

What was the Generation of 1898?

What is the significance of the *jarchas* in the history of literature?

Who were the two most important dramatists of Spain's Golden Age?

Why is *The Cid* more realistic than other medieval epic poems?

What are the characteristics of the *picaresque* novel?

What were the contributions of Benito Pérez Galdós to Spanish literature?

How does *conceptismo* differ from *culteranismo?* Why are both characteristic of the baroque style?

Who was Spain's greatest and best-known writer?

SPANISH MAIN was the name English buccaneers and pirates gave to the northern coast of South America. By 1550, Spain controlled the Caribbean Sea, the West Indies, and large areas of the South American mainland. *Spanish Mainland* referred to what are now Colombia and Venezuela. English seamen shortened the name to *Spanish Main.*

SPANISH MOSS is a flowering plant that hangs from trees in the southeastern United States and in tropical South America. Its long, slender, grayish stems look like hair hanging from the trees. It is neither a true moss nor a parasite. The plant has no roots, and absorbs water directly from the air. It has long, narrow leaves and small yellow flowers. Its stems are dried and used to stuff upholstery.

Scientific Classification. Spanish moss belongs to the pineapple family, *Bromeliaceae.* It is genus *Tillandsia,* species *T. usneoides.* ROBERT W. HOSHAW

See also AIR PLANT.

SPANISH PHALANX. See FALANGE ESPAÑOLA.

SPANISH SAHARA is a province of Spain that lies on the northwest coast of Africa. It is divided into two parts—Southern Region (formerly Río de Oro) and Northern Region (formerly Saguia el Hamra). El Aiún is the provincial capital and capital of Northern Region. Villa Cisneros is the capital of Southern Region.

Most of the 147,000 people in Spanish Sahara are Arabs and Berbers. These people move about constantly, seeking water and grass for their herds of camels, goats, and sheep. Some work as fishermen near El Aiún. Most of the people are Moslems. They are related to the people of neighboring Morocco and Mauritania, and they wander back and forth across the borders of these countries freely.

Most of Spanish Sahara's 102,703 square miles (266,000 square kilometers) is barren, rocky desert. The province gets little rainfall. Vegetation is scanty except

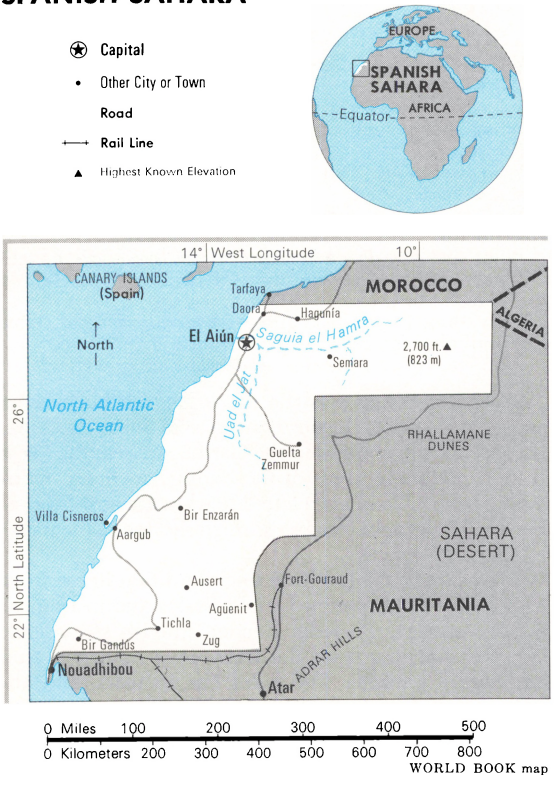
SPANISH SUCCESSION, WAR OF THE

for patches of coarse grass and low bushes near the coast. Iron ore deposits have been discovered inland, but they have not been developed because there are no roads to the region.

Spain claimed Spanish Sahara in 1509. Morocco ruled it from 1524 until Spain regained control in 1860. Spanish Sahara became a province of Spain in 1958. JAMES W. FERNANDEZ

See also EL AIÚN.

SPANISH SAHARA



SPANISH SUCCESSION, WAR OF THE. See SUCCESSION WARS.

SPANISH WAR VETERANS, UNITED, is an organization founded in 1898 by some of the men who took part in the Spanish-American War. The United Spanish War Veterans has about 1,000 members in about 300 local groups throughout the United States and its possessions. The organization works to gain government benefits for its members, and to help needy veterans and their families. Its headquarters are at 810 Vermont Avenue NW, Washington, D.C. 20005. HARRY E. WILLIAMS

SPANISH WEST AFRICA was a group of territories held by Spain on the northwest coast of Africa. It consisted of Ifni, Spanish Sahara, and Morocco Southern Zone. Ifni and Spanish Sahara became provinces of Spain in January, 1958. Spain ceded Morocco Southern Zone, a strip of land along the Dra River, to Morocco in 1958, and the province of Ifni to Morocco in 1969. See also IFNI; SPANISH SAHARA.

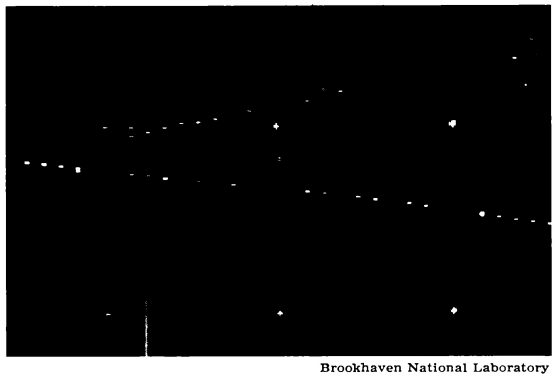
SPARK CHAMBER is a device which makes visible the paths followed by electrically charged atomic particles. Nuclear physicists use spark chambers to study these particles, which are too small and travel too fast to be seen by the naked eye. Two Japanese physicists, S. Fukui and S. Miyamoto, built the first practical spark chamber in 1959. Since 1960, the spark chamber has become an important research tool for high energy nuclear physicists. Physicists use it with similar devices called the Wilson cloud chamber and the bubble chamber. But unlike these devices, the spark chamber can be made sensitive for just the short interval that a particle a physicist wants to study is in the chamber.

A spark chamber is made of a series of thin metal plates set parallel in an airtight box that is filled with neon gas. A gap of from 3 to 400 millimeters separates the plates, depending upon the design of the chamber. A typical chamber about 3 feet (91 centimeters) long has 150 plates spaced 6 millimeters apart. Electrical equipment powers the chamber.

The spark chamber is most often used with an atomic particle accelerator. The accelerator makes high energy particles that can be studied in the chamber. When a charged atomic particle enters the chamber, it *ionizes* (electrically charges) the neon gas atoms in its path. The particle simply penetrates the thin metal plates. The ionized gas atoms will conduct electricity but the atoms that have not ionized will not. An electrical field of 1,000 volts per millimeter of plate separation is applied to alternate plates immediately after the particle ionizes the neon. This field causes a lightninglike spark to jump from plate to plate along the ionized path of the particle. The spark can easily be seen and photographed.

Special electronic circuits apply the high voltage to the plates only after a selected particle enters the chamber. Physicists can select the particle they wish to study in the chamber. By eliminating unwanted particle *tracks* (paths), the physicist can spend more time studying the important tracks. By studying the tracks made by atomic particles, physicists learn more about the atom and atomic particles. Several previously unknown particles have been discovered by experiments with spark chambers. GERARD K. O'NEILL

See also ATOM; BUBBLE CHAMBER; PARTICLE ACCELERATOR; WILSON CLOUD CHAMBER.



Brookhaven National Laboratory

Sparks Show Up in a Spark Chamber, tracing the paths charged atomic particles followed through the chamber. Photographs of these paths help physicists study the particles.

SPARK COIL. See IGNITION.

SPARK PLUG. See IGNITION.

SPARKMAN, JOHN JACKSON (1899-), an Alabama Democrat, has served in the United States Senate since 1947. He was the Democratic nominee for Vice-President of the United States in 1952. Sparkman became chairman of the Senate Foreign Relations Committee in 1975. In Congress, Sparkman generally supported the policies of the Democratic Presidents except in civil rights policies. He usually backed Republican Presidents Dwight D. Eisenhower, Richard M. Nixon, and Gerald R. Ford on foreign policy.

Sparkman was born near Hartselle, Ala., and attended the University of Alabama. He served as a U.S. representative from 1937 to 1947. F. JAY TAYLOR

SPARKS, JARED (1789-1866), was an American historian and biographer who pioneered in collecting original documents on American history. His works include the 12-volume *The Writings of George Washington* (1834-1838), *The Library of American Biography* (1834-1838), and the 10-volume *The Works of Benjamin Franklin* (1836-1840). Sparks was born in Willington, Conn. He served as a Unitarian minister from 1819 to 1823. He also held the position as editor for the *North American Review* from 1824 to 1831. He became president of Harvard University in 1849. MERLE CURTI

SPARROW is the name of many small, common birds. The name comes from the Anglo-Saxon word *spearwa*, which probably was a general term for all small birds. Today, it applies especially to many members of the finch family, which are found throughout the world except in Australia. In America, about 35 species of this family are called *sparrows*. Other sparrows include the *hedge sparrows* of Europe and Asia and European *house* and *tree sparrows*.

Most American sparrows are plain-looking, brownish birds. Many sparrows are noted for their musical songs. Among these are the *song sparrow*, *vesper sparrow*, *lark sparrow*, *white-crowned sparrow*, *white-throated sparrow*, *fox sparrow*, and *Lincoln's sparrow*.

Sparrows usually eat seeds, but during the nesting season they also eat insects. The birds build nests on the ground, in clumps of grass, in bushes, or in low trees, but seldom far from the ground. The *chipping sparrow*, or *chippy*, builds its nest in a higher place than other sparrows do. Sometimes the nest may be found in evergreens 25 feet (8 meters) above the ground. The sparrow's nest is a compact, well-built, open structure made of grasses, plant fibers, and sometimes small twigs. The female lays four or five white eggs that are marked with reddish-brown.

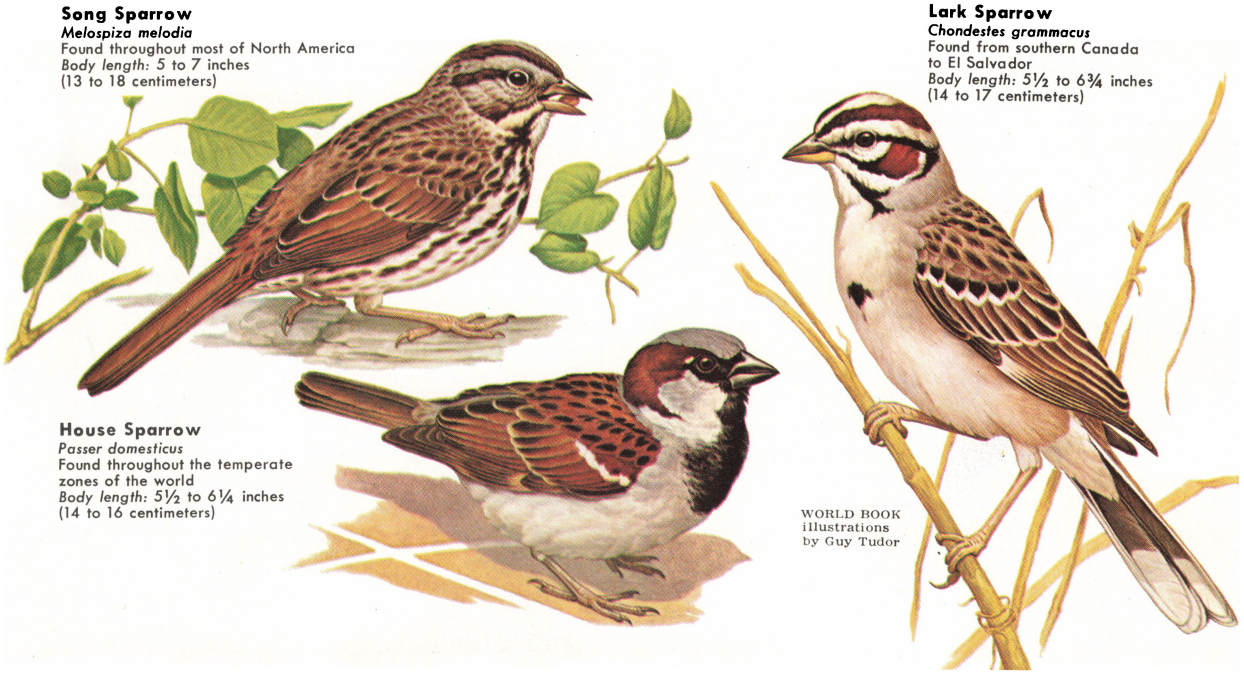
American sparrows live almost everywhere. For example, song sparrows live in bushy areas, fox sparrows in forests, swamp sparrows in marshes, vesper sparrows in prairies and sage sparrows in deserts. Those that live in cold regions usually migrate southward in winter. Some go to Mexico, others to Central America.

The common house sparrow, often called the *English sparrow* in America, originally lived throughout Europe. It was brought to America in 1850 and now lives in most of the populated regions of Canada, the United States, and northern Mexico.

Scientific Classification. American sparrows belong to the finch family, *Fringillidae*. The song sparrow is genus *Melospiza*, species *M. melodia*. Lincoln's sparrow is *M. lincolnii*, and the swamp sparrow is *M. georgiana*. The white-throated sparrow is *Zonotrichia albicollis*, and the white-crowned sparrow is *Z. leucophrys*. The chipping sparrow is *Spizella passerina*, the fox sparrow *Passerella iliaca*, and the vesper sparrow *Pooecetes gramineus*. The sage sparrow is *Amphispiza belli*, and the lark sparrow is *Chondestes grammacus*. Hedge sparrows are in the accentor family, *Prunellidae*. European house and tree sparrows are in the weaver finch family, *Ploceidae*. The house, or English, sparrow is genus *Passer*, species *P. domesticus*. LEONARD W. WING

See also BIRD (Building the Nest; Eggs; color pictures: Birds' Eggs, Birds That Help Us); ENGLISH SPARROW; LIFE (table: Length of Life of Animals).

SPARROW HAWK is a bird of prey that lives in Africa, central Asia, and Europe. It resembles the American Cooper hawk and the sharp-shinned hawk. The American kestrel is sometimes called the American sparrow hawk, but this bird is actually a type of falcon (see KESTREL).



E. V. Breeze Jones, Bruce Coleman Inc.

The Sparrow Hawk preys on sparrows and other small birds. This small hawk lives in Africa, central Asia, and Europe.

The male and female sparrow hawk both have a white breast with brown or reddish-brown bars. The tail is gray and has from three to five dark stripes. The male has a gray back and a whitish spot on the back of its neck. The female has a brown back. Sparrow hawks have short, broad wings and a long, slim tail. These features help them swerve in the air to catch prey. The males measure about 12 inches (30 centimeters) long. The females are about 15 inches (38 centimeters) long.

The bird got its name because it eats mostly sparrows. It also preys on other small birds and small animals. Most sparrow hawks build their nests in evergreen trees, but they occasionally nest in shrubs. The female lays from three to six whitish eggs spotted with brown.

Scientific Classification. The sparrow hawk belongs to the hawk family, *Accipitridae*. It is genus *Accipiter*, species *A. nisus*.

RICHARD F. JOHNSTON

See also HAWK.

SPARS is the popular name for members of the United States Coast Guard Women's Reserve. The name *SPAR* is taken from the first letters of the coast guard motto and its English translation, **S***emper* **P***aratus* (**A**lways **R**eady). Unlike women in other branches of the armed forces, all SPARS are in the military reserve. SPARS come under the command of the Coast Guard, which is part of the Department of Transportation.

SPARS have no active duty enlistment program, but women may enlist in reserve units. There are about 120 SPAR officers and 50 enlisted women in the inactive reserve program. Fewer than 20 officers and enlisted women serve on active duty.

The group was formed in November, 1942, to free coast guardsmen for sea duty in World War II. By the war's end, the SPARS had 10,000 enlisted women and 1,000 officers. All were discharged or placed on inactive duty by June, 1946. The group was then dissolved, but it was reactivated in November, 1949.

Critically reviewed by the U.S. COAST GUARD

SPARTA, or LACEDAEMON, *lass ee DEE mohn*, the capital of Laconia, was at one time the most powerful city-state of ancient Greece. It was famous for its military power and its loyal soldiers. The greatest honor that could come to a Spartan was to die in defense of his country. Endurance, a scorn of luxuries, and unyielding firmness are still spoken of as Spartan virtues.

The Land. Sparta was situated in a lovely, sheltered valley on the bank of the Eurotas River. For location, see GREECE, ANCIENT (color map). It was protected on three sides by mountains. The climate was mild, and the soil was fertile and well watered. Sparta had few mineral resources. Spartans obtained marble and a little iron from nearby Mount Taygetus.

The People belonged to three classes. The Spartans themselves were descended from the Dorians, a people who invaded the Greek peninsula about 1000 B.C. They were the ruling class of Sparta and were the only ones who had full rights of citizenship. They enslaved the earlier Greek peoples of Laconia, the Achaeans and Ionians. These enslaved Greeks, called *helots* (pronounced *HELL ut*) outnumbered the Spartans. Some of the non-Spartan Greeks escaped enslavement. They were not citizens, but they lived in Sparta as free men. This group was known as the *perioeci* (pronounced *PAIR ih EE sigh*). The numbers of the three classes varied widely during Sparta's long history. Some authorities estimate that at the height of Spartan power there were about 25,000 citizens, an unknown number of perioeci, and as many as 500,000 helots.

Way of Life. Spartan citizens could engage only in agriculture. A few aristocrats owned their land, but most citizens held state-owned plots. A citizen who could not make enough from his estate to support his family and pay the taxes lost his land to someone who could make it pay. He also lost his citizenship. It was therefore dangerous to try to rear a large family. The Spartans sometimes left unwanted children in a deep cavern in the mountains to die.

Because citizens were not allowed to carry on manufacturing or trade, these pursuits were taken over by the perioeci. Some of them grew wealthy.

The helots farmed the soil, and each had to give a fixed amount of produce to his master. The rest, which was often little, went to the helot himself. The helots bitterly resented their lot, and revolts were not unusual. Once a year the Spartans officially declared war on the helots, so that they could kill any who seemed rebellious without breaking the law against murder.

Every Spartan belonged to the state from the time of his birth. A boy was left to the care of his mother until he was seven years of age, when he was enrolled in a company of 15 members, all of whom were kept under strict discipline. From the age of seven, every Spartan had to take his meals with his company in a public dining hall. The bravest boy in a company was made captain. The others obeyed his commands and bore such punishments as he decided they should have.

When the boys were 12, their undergarments were taken away and only one outer garment a year was allowed them. Their beds consisted of the tops of reeds, which they gathered with their own hands and without knives. Spartans did not consider the arts of reading and writing necessary. Boys learned the *Iliad* and songs of war and religion, but leaping, running, wrestling, and

wielding a weapon with grace and accuracy were held much more important. Between the ages of 20 and 30, Spartan youths served as cadets who policed the country, kept the helots in order, and exacted disciplined obedience from the enslaved people.

At the age of 30, a Spartan attained full maturity and enjoyed the rights and duties of citizenship. He might marry, attend meetings of the assembly, and hold public office. At 60, his military career ended, and he worked either in public affairs or in training the young.

As a result of this system, the Spartan men became tough, proud, disciplined, and noted for obstinate conservatism and for brevity and directness of speech. From childhood, life was one continuous trial of endurance. All the gentler feelings were suppressed.

Spartan women, on the other hand, lived the freest life of any women in Greece. As girls, they engaged in athletics, and as women, they ran their own households. They engaged in business, and many became wealthy and influential. Aristotle tells us that women owned two-fifths of the land in Sparta.

History. The Dorians who settled in Sparta extended their control over all Laconia at an early date. In the 700's B.C., they conquered Messenia, the rich farming region to the west of Mount Taygetus. Sparta failed to conquer the cities of Arcadia, but forced them to enter the Peloponnesian League. The members of the league were obliged to follow Sparta in war. By the middle of the 500's B.C., this league included most of the cities in southern and central Greece.

Sparta conquered Athens, the leader of the powerful Athenian Empire, in the hard-fought Peloponnesian War. In 404 B.C., the Athenians were forced to accept a humiliating peace treaty. But the leadership won by Sparta was short-lived. The Spartans ruled over the other Greek states so cruelly that they revolted and threw off the Spartan yoke. At the battle of Leuctra, in 371 B.C., Sparta lost forever its claim to supremacy in Greece. But it remained a powerful city for the next 200 years. In 146 B.C., it came under the rule of Rome.

There is a modern town of Sparta (pop. 10,412) near the site of the ancient city. It was laid out about 1835 and made the capital of the modern political division of Laconia. Excavations have been made on the old site, and much valuable material has been discovered from the early city's history. DONALD KAGAN

Related Articles in WORLD BOOK include:

Dorians
Greece, Ancient (The Government of Sparta)
Laconia
Leonidas I
Lycurgus
Lysander
Messenia
Peloponnesian War

SPARTACUS (? -71 B.C.), was the most famous of all Roman gladiators. But he won his fame as the leader of a great slave uprising, rather than in the arena.

Spartacus was born in Thrace. He was captured by the Romans while serving as a soldier, and was sold as a slave to be made a gladiator (see GLADIATOR). With 70 comrades, he escaped, hid on Mount Vesuvius, and raised a large army of rebel slaves from the farms of Italy.

His forces conquered most of southern Italy and defeated two Roman armies. Spartacus wanted to lead his men over the Alps and out of Italy back to their homes, but the slaves forced him to lead them in a march on Rome. They lost their courage, however, and quarreled among themselves. A fresh Roman army under Marcus Licinius Crassus finally defeated them (see CRASSUS, MARCUS LICINIUS). Many were crucified as a warning to other slaves. Spartacus himself fought courageously until he was killed. CHESTER G. STARR

SPARTANBURG, S.C. (pop. 44,546), is an important center for the manufacture of cotton textiles. It is also the trading center of a peach-growing region. Spartanburg lies in northwestern South Carolina, 15 miles (24 kilometers) from the North Carolina border (see SOUTH CAROLINA [political map]). Spartanburg and Greenville, S.C., form a metropolitan area with a population of 473,454.

Spartanburg is the home of Converse and Wofford colleges. It was chosen as the seat of Spartanburg County in 1785. Both county and town were named for the Spartan Regiment, a South Carolina militia group that fought in the Revolutionary War. Spartanburg has a council-manager government. For the monthly weather, see SOUTH CAROLINA (Climate). JULIAN J. PETTY

SPASM. See CRAMP; TETANY.

SPASTIC PARALYSIS is a form of *cerebral palsy*, a condition in which damage to the brain has resulted in poor control over the muscles. The brain damage usually occurs at birth, although it can happen before birth. Spastic paralysis can also develop after birth if an infection such as meningitis damages the brain, or if damage results from strokes, skull fractures, or other injuries.

The part of the brain that is damaged and the amount of damage done determine which muscles are affected and how severely. Sometimes the damage is so slight that the individual may have only a little clumsiness, a slight loss of balance, or perhaps a slight speech difficulty. In severe cases, the individual cannot walk. Or he may walk on his toes with his feet turned inward, his knees together, and with one leg crossing over in front of the other, in the typical "scissors gait" of the spastic. Spastic paralysis can affect all the muscles. The face, the tongue, and even the muscles that control breathing may be affected. This may result in uncontrollable grimacing, drooling, and great difficulty in speaking.

Many persons suffering from spastic paralysis are completely normal, except for their difficulties in controlling the affected muscles. But in some cases, brain injury does affect the individual's intelligence. Even mental retardation may occur. Nevertheless, thousands of persons with spastic paralysis have above-average intelligence.

The brain damage cannot be cured, but the use of the muscles can be improved through surgery, training, and the use of crutches and braces. Spastics can be taught to speak more effectively, to care for themselves, and to earn their own living.

The spastic patient should be treated as a normal person, except for the special training that may be required. Spastic children should be encouraged to play with other children and live as normal a life as possible while their muscle use is being improved. It is important, too, for people to understand that spastic paralysis is not a communicable disease, that it is not inherited, and that it is not a form of mental illness. A person should not be ashamed of spastic paralysis any more than he should be ashamed of wearing glasses. M. A. PERLSTEIN

See also CEREBRAL PALSY.

SPASUR. See RADAR (Space Surveillance).

SPATHE. See LEAF (Leaves That Keep the Plant Warm); ARUM; JACK-IN-THE-PULPIT.

SPAVIN, *SPAV in,* is a common name for two unrelated diseases which affect the hocks of horses. The hock is the ankle joint of the hind leg. *Bone spavin,* or true spavin, is a bony growth usually on the inner and lower part of the joint. The disease is caused by a lack of certain minerals in the bones. *Bog spavin* is a swelling of a capsule of tissue of the main joint. It is believed to exist at birth and seldom causes any trouble. Both are seldom curable. Bone spavin, however, can be treated to end lameness and to keep the growth from enlarging.

SPAWN is the eggs of fishes, mollusks, frogs, and other animals. Usually such eggs are produced in great numbers, particularly by sea animals that are eaten by larger species, or that leave eggs and young to hatch and develop alone. These water animals must produce thousands or millions of eggs to keep from dying out. The eggs of certain fish, particularly the sturgeon, are often used in making the delicacy known as *caviar.* The eggs of fishes are also called *roe,* particularly when used as human food. Shad roe is particularly favored. See also CAVIAR; FISH (How Fish Reproduce); SALMON (The Life of a Salmon); STURGEON. CARL L. HUBBS

SPAYING. See PET (Birth Control).

SPEAKER is an electric device that reproduces sound. Speakers form part of phonographs, radios, tape players, and television sets. They also are part of public address systems and equipment used to amplify sound created by musicians and other performers.

Most speakers have three main parts: (1) a coil of wire called a *voice coil,* (2) a permanent magnet, and (3) a cone-shaped piece of paper or plastic called a *diaphragm.* Electric waves from an amplifier pass through the voice coil and produce varying magnetic forces in the coil. The magnetic forces drive the coil alternately toward and away from the permanent magnet in rapid vibrations. The diaphragm, which is attached to the voice coil, vibrates with it. The vibrations of the diaphragm produce vibrations in the air. The ear hears these air vibrations as sound.

Some equipment has several speakers, each of which reproduces high-, medium-, or low-pitched sounds. A speaker that reproduces only high-pitched sounds is called a *tweeter.* A *squawker* reproduces sounds in the middle range of pitch, and a *woofer* reproduces low-pitched sounds. In general, a system of such specialized speakers provides sound reproduction of higher fidelity than a single speaker. Speakers in high-fidelity systems are mounted in wooden or plastic cabinets. The size and shape of these cabinets determines the tone quality of the sounds made by the speakers. MITCHELL G. HELLER

See also HIGH FIDELITY; PHONOGRAPH; RADIO.

SPEAKER is the title of the presiding officer in the lower house of several national, state, and provincial legislatures. The duties of the office differ in various legislative bodies.

In the United States, the speaker of the House of Representatives can wield great power. He is the recognized leader of his political party in the House, as well as the presiding officer. He is expected to use his office to promote his party. He ranks next after the Vice-President in order of presidential succession. He receives a yearly salary of $62,500 and $10,000 for his expenses.

The early speakers considered themselves simply as presiding officers, and tried to be impartial. Henry Clay, elected speaker in 1811, began the practice of using the office for party purposes. The office reached its height as a political force under the strong personalities of Thomas B. Reed, who served as speaker from 1889 to 1891 and again from 1895 to 1899, and Joseph G. Cannon, speaker from 1903 to 1911.

For a time the speaker was considered almost as important as the President. In 1910 he was removed from the Committee on Rules, and his control over the appointment of committees was taken away. But the speaker is still important in national legislation. For the powers, duties, and methods of selection of the speaker of the House, see HOUSE OF REPRESENTATIVES.

In Great Britain, a speaker has presided over the House of Commons since at least 1377. The speaker of Commons should be a model of impartiality. He must rule according to the will of the majority, but never permit the minority to be abused. The House elects each new speaker. It is the custom to re-elect the same speaker in all Parliaments until he dies or retires.

The office of speaker in the House of Commons has great dignity. It carries a salary of 13,000 pounds (about $31,000) a year, and an official residence in the Palace of Westminster. When the speaker retires, he becomes a peer, or nobleman. GEORGE E. MOWRY

SPEAKER, TRIS (1888-1958), a great American baseball player, was known as the "Gray Eagle" because of his gray hair and his speed in playing the outfield. He won fame with the Cleveland Indians and played in the American League from 1907 to 1928. Speaker had a lifetime batting average of .344, which places him in an all-time outfield with Babe Ruth and Ty Cobb. His highest batting mark was .389 in 1925.

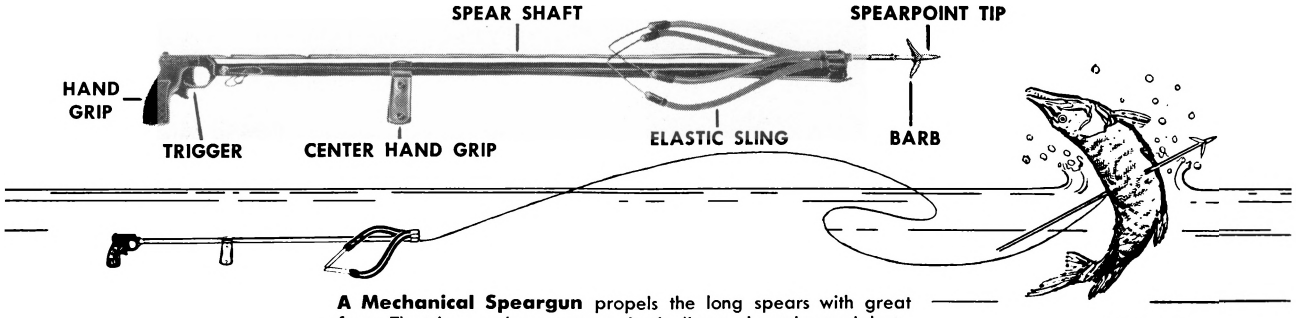
Speaker managed the Indians from 1919 to 1926, winning the World Series in 1920. He was elected to the National Baseball Hall of Fame in 1937. Tristram E. Speaker was born in Hubbard, Tex. ED FITZGERALD

SPEAR has played an important part in history from earliest times. It ranked as the chief weapon used in the battles of ancient Asia and Europe. The famous Greek poet, Homer, tells how Achilles speared Hector through the neck with a "pole heavy with bronze." The early Persians added a sharp spike to the back end of the spear so that both ends could be used. The Romans used a short, heavy spear called a *pilum.* The Gauls fought with a huge, clublike spear. Illyrian soldiers carried a fine, light javelin. In India, soldiers mounted on charging horses threw the lance, a weapon similar to the

Spearheads Changed as men learned to make them of new materials. Early men tied jagged pieces of stone onto their throwing sticks. Then they learned to shape pointed spearheads from pieces of flint. Metals made the best spearheads of all.

Prehistoric Flint-Tipped Spear

Egyptian Bronze Spearhead



A Mechanical Speargun propels the long spears with great force. The trigger releases a taut elastic sling to shoot the steel darts. U.S. Divers Co.

javelin. The Bedouins of Arabia were famous for their skill in using the lance on horseback.

Today, the spear is used chiefly in fishing. Eskimos kill seals and fish with spears through holes in the ice. Persons who enjoy underwater swimming often use spearguns with great accuracy. These spearguns shoot spears by means of springs, rubber bands, or compressed gas. JACK O'CONNOR

See also JAVELIN.

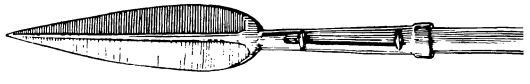
SPEARE, ELIZABETH GEORGE (1908-), an American author, won the Newbery medal in 1959 for *The Witch of Blackbird Pond* and in 1962 for *The Bronze Bow*. She also wrote *Calico Captive* (1957). Mrs. Speare was born in Melrose, Mass., and was graduated from Boston University.

SPEARFISH. See MARLIN.

SPEARFISH, S.Dak. See PASSION PLAY (picture).

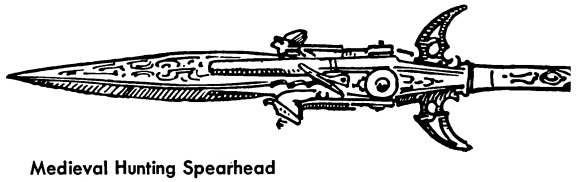
SPEARFISHING, or UNDERWATER HUNTING, is the sport of shooting fish under water. Some spearfishermen shoot spears to kill fish. Others shoot a harmless dart with a narrow strip of plastic attached to it. The plastic strip sticks to the fish, and can be useful in studying the migration and growth of fish.

Spearfishermen usually shoot fish with a speargun. Most spearguns are built like crossbows. A small bow is mounted on a long shaft. The spearfisherman draws the *bowstring* (large rubber band) back and hooks it on a catch. By pulling a trigger, the hunter releases the catch and shoots a small spear that is attached to a line about 15 feet (5 meters) long. Other spearguns are powered by compressed gas, springs, or rubber slings.



Greek Bronze Spearhead

Roman Iron Spearhead



Medieval Hunting Spearhead

Arrowheads that explode may be used to drive the spear into the fish. But most spearfishermen consider exploding arrowheads unsportsmanlike and dangerous to the spearfisherman.

Spearfishing equipment includes a mask that goes over the nose and eyes, foot fins to aid in swimming, and a *snorkel* (short breathing tube). Most spearfishermen consider it unsportsmanlike to hunt to kill using an independent breathing device such as an aqualung. The use of such equipment is illegal in many places.

The spearfisherman swims along the surface, face down. When he sights a fish, he takes a breath and executes a *coup de reins*. A *coup de reins* is a quick dive in which the diver bends from the waist, snaps his legs straight into the air, and dives toward the fish. If the spearfisherman is hunting to kill, he shoots the fish, rises to the surface, and then pulls in the fish.

Many hunters prefer not to kill fish. Instead, they shoot the fish with the dart. These fishermen belong to a research group. The strip of plastic attached to the dart carries the number of the diver, which has been assigned by his research group. After the spearfisherman shoots a fish, he files a card with his group that tells the size and location of the fish. If the fish is caught later, the card furnishes information that may be compared with its present size and location.

Expert spearfishermen may dive from 60 to 100 feet (18 to 30 meters) to find fish. Some fish hunters have tried to hold their breath longer than they normally can by taking several deep breaths or by breathing pure oxygen before diving. This *hyperventilates* (increases the amount of oxygen in) the lungs, and may cause the diver to faint or even to die. Overwork while holding the breath under water is also dangerous. Overwork raises the level of carbon dioxide in the diver's blood stream and has an effect similar to hyperventilation.

Spearfishing for food probably began thousands of years ago. Spearfishing became a popular sport during the 1900's. Shooting darts for scientific research began in the 1950's. JAMES DUGAN

See also SKIN DIVING; DIVING, UNDERWATER.

SPEARMINT is a type of mint plant that grows in most of the temperate regions of the world. It yields an oil used in making perfumes, medicine, chewing gum, candies, and mint jelly or sauce. It has smooth, erect stems 1 to 2 feet (30 to 61 centimeters) high, topped with spikes of lavender or white flowers. Most spearmints in

L. W. Brownell

Spearmint Plants Have Spear-Shaped Flowers.

the United States grow in Indiana, Michigan, and Washington.

Scientific Classification. The spearmint belongs to the mint family, *Labiatae*. It is classified as genus *Mentha*, species *M. spicata*. HAROLD NORMAN MOLDENKE

SPEBSQSA. See BARBERSHOP QUARTET SINGING.

SPECIAL ACTION OFFICE OF DRUG ABUSE PREVENTION. See PRESIDENT OF THE UNITED STATES (The Executive Office).

SPECIAL DELIVERY. See POST OFFICE (Services).

SPECIAL DRAWING RIGHTS are reserve assets entered in the books of the International Monetary Fund (IMF) as credits for member nations. A member may use this special account to obtain needed foreign currency from another member. Special drawing rights are often called "SDR's" or "paper gold." They are not real money and have no gold backing, but they have a full guarantee of gold value. Member nations may transfer SDR's among themselves to settle their debts.

The IMF created special drawing rights in 1969 to supplement international reserves of gold and national currencies, especially the United States dollar. SDR's represented a more reliable and internationally better controlled medium of exchange. Gold supplies could no longer meet the demand for reserve backing.

In addition, the dollar had two drawbacks. Some Europeans thought its use as an international currency gave the United States too much power in international finance. Some Americans thought a dollar-based exchange placed too much international responsibility on U.S. domestic economic policy. HARRY G. JOHNSON

See also INTERNATIONAL MONETARY FUND; MONEY (International Reserves).

SPECIAL EDUCATION is a teaching program designed for children who need unusual help to use their full learning ability. These children may have physical, mental, or emotional handicaps, or they may be highly gifted. Teaching such children requires special skills and materials. Some schools provide special classrooms and equipment for handicapped or gifted students.

Educators believe that whenever possible, handicapped children should not be educated separately from the nonhandicapped. Separation makes such children sensitive about their handicap and decreases their ability to deal with the problems of life. Many schools educate both groups in the same classrooms, but they provide special services for the handicapped.

Physically Handicapped Children have some form of body damage that hinders their learning. They include children handicapped by blindness, brain injury, deafness, or a speech problem.

Many children with a severe physical handicap are educated in special schools, and some may require care in an institution. But many can be taught in a regular classroom with help from a teacher trained in special education. For example, most totally blind children learn through *talking books* (recordings of books on phonograph records or tapes). Children with partial vision attend special schools or public schools. Their teachers encourage them to use books with large print.

Mentally Handicapped Children have intelligence far below average, as shown by various intelligence tests. Children with severe mental handicaps may be taught in special schools or institutions for the mentally retarded. There they learn to perform elementary tasks, such as dressing and feeding themselves. Mildly retarded children often cannot keep up with the nonhandicapped in a regular course of study. Many such children attend public school, where they take a course suited to their abilities. See MENTAL RETARDATION.

Children with specific learning disabilities may have normal intelligence, but they experience difficulty learning certain school subjects. Many of these children have problems with reading and writing. For example, they may not be able to easily distinguish between *b* and *d*, or *p* and *q*. Or they may reverse letters in words, so that *was* becomes *saw* and *tub* is read as *but*. Such children may need special teachers and materials to succeed in school.

Lynn McLaren, Rapho Guillumette

A Mentally Retarded Child learns to imitate simple movements made by a teacher while playing a game with their hands. Many severely retarded children, aided by specially trained teachers, can learn to dress and feed themselves.

Emotionally Handicapped Children cannot control their feelings in an acceptable way. As a result, they have behavior problems that require special handling in school. Many children with severe emotional problems attend schools that provide full-time psychiatric care. But most children who have emotional difficulties attend a regular public school and receive special help.

Gifted Children may have higher than normal intelligence, or they may have exceptional artistic, mathematical, musical, or scientific ability. Although they are not handicapped, they need special arrangements and equipment to fully use their ability to learn. Many go through school at an accelerated rate.

Some schools remove gifted children from the regular classroom and teach them in special classes. Other schools provide special activities and materials that encourage the gifted child to develop at his own rate within the regular classroom. PERCY BATES

See also EDUCATION (Kinds of Education).

SPECIAL FORCES. See ARMY, UNITED STATES (Special Forces).

SPECIAL HANDLING. See POST OFFICE (Services).

SPECIAL LIBRARIES ASSOCIATION is an organization of professional librarians and information specialists whose members serve institutions that require or provide specialized information. Such institutions include businesses, museums, newspapers, research organizations, technical schools, and special departments of public and university libraries. The association works to promote learning through the collection, organization, and distribution of library materials. It has more than 7,000 members in Canada, the United States, and other countries. It was founded in 1909. The association's official journal is *Special Libraries*. It also publishes *Technical Book Review Index*, *Scientific Meetings*, and books and bibliographic aids in library and information science. Headquarters are at 235 Park Avenue S., New York, N.Y. 10003.

Critically reviewed by the SPECIAL LIBRARIES ASSOCIATION

SPECIAL SESSION. See CONGRESS OF THE UNITED STATES (When Congress Meets).

SPECIE CIRCULAR. See JACKSON, ANDREW (The Money Surplus).

SPECIE PAYMENTS, RESUMPTION OF, refers especially to the redeeming of paper money with gold by the United States Treasury. This action started on Jan. 1, 1879. *Specie* means *coin*, usually gold or silver coin.

Nations using metals as standard money often suspend specie payments when a war begins or during periods of economic strain. Both the U.S. Treasury and commercial banks stopped payments from 1861 to 1879. Between 1862 and 1865, the U.S. Treasury issued $450 million of United States notes, called *greenbacks*. The government used these notes to help pay the costs of the Civil War. But greenbacks could not be exchanged for gold or silver, so they lost value.

Various government and banking policies gradually reduced the amount of greenbacks in circulation. The Resumption Act of 1875 provided that, beginning on Jan. 1, 1879, people could exchange their greenbacks for gold. Greenbacks were redeemable in gold until 1933, when the United States formally abandoned the gold standard (see GREENBACK). ARTHUR A. WICHMANN

SPECIES, *SPEE sheez*, is the basic unit of scientific classification. Animals and plants are classified in groups called kingdoms, phyla, classes, orders, families, genera, and species. Members of a single species are more closely related than are members of any other group. Members of a species breed with one another, but one species usually does not breed with another under natural conditions. The name of a species always has two parts. The first part is the name of the genus to which the species belongs. The second word is an adjective. Together they form the name of a particular animal or plant. For example, the wolf is named *Canis lupis*. See also CLASSIFICATION. WILLIAM V. MAYER

SPECIFIC GRAVITY. See GRAVITY, SPECIFIC.

SPECIFIC HEAT of a substance is the amount of heat needed to raise the temperature of a unit mass of the substance (1 pound or 1 gram) by 1 degree. In the metric system, one *calorie* of heat energy will raise the temperature of 1 gram of water 1 degree Celsius. The unit in the English system is the British thermal unit (B.T.U.). One B.T.U. will raise 1 pound of water 1 degree Fahrenheit. ROBERT LINDSAY

See also BRITISH THERMAL UNIT; CALORIE; HEAT (Changes in Temperature; picture: The Specific Heats); TEMPERATURE.

SPECIFIC IMPULSE. See SPACE TRAVEL (Overcoming Gravity).

SPECTACLES. See GLASSES (History).

SPECTATOR, THE. See ADDISON, JOSEPH.

SPECTROGRAM. See ASTRONOMY (table: Terms).

SPECTROGRAPH is an instrument for photographing a *spectrum*, the pattern of colors formed by light passing through a prism. A spectrograph is a spectroscope with a camera instead of a telescope. See also SPECTROSCOPE; LIGHT (The Visible Spectrum).

SPECTROHELIOGRAPH, *spehk troh HEE lee uh graf*, is an apparatus that allows one color of the sun's spectrum to be photographed. An image of the sun, obtained through a telescope, is allowed to pass through the slit of a spectrograph. The spectrum thus obtained is transmitted through a second slit that allows only light of a selected wave length to pass to a film behind it. See also SPECTROSCOPE. JOSEPH VALASEK

SPECTROPHOTOMETER. See COLOR (Measuring Colors).

SPECTROSCOPE, *SPECK troh skohp*. Substances heated to a high temperature give off light. This light may be separated into a pattern of colors by passing it through a prism (see PRISM). The pattern is the *spectrum* for that substance. No two materials have the same spectrum. For this reason, an expert can identify any substance by its spectrum. Any instrument he uses to examine spectra is called a *spectroscope*.

The simplest spectroscope is a triangular glass prism. A person who looks through a prism, preferably with the aid of a small telescope, sees a band of colored images of the light source. These tend to overlap and blend into each other. Less overlapping occurs if the source is narrow and its images are sharply focused. For the best possible separation of the colored images, the light source is placed behind a narrow slit. The slit is attached to one end of a tube, and a lens is attached to the other end, so that a beam of parallel light rays emerges from the lens. This part of the spectroscope is the *collimator*. The light from the collimator passes

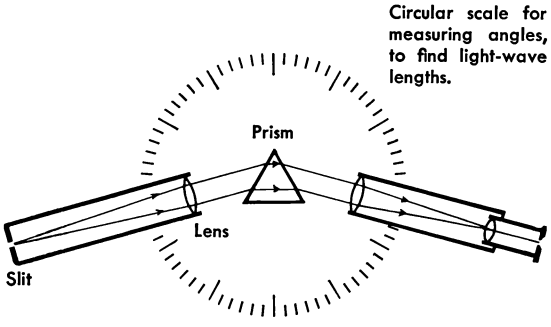
through the prism and then through a telescope to the eye of the observer.

Spectra of heavenly bodies are often obtained with a compound spectroscope. This consists of a series of prisms arranged in the arc of a circle. The spectroscope is attached to the eyepiece end of a large telescope that forms an image of the heavenly body on the slit of the spectroscope. By using spectra obtained in this way, an astronomer can determine the chemical composition of the sun and the stars, and of the atmosphere of planets. The astronomer can also determine the speed at which the body is moving toward or away from him by measuring small shifts in the spectrum lines (see RED SHIFT).

A spectroscope may use a diffraction grating instead of a prism to separate light into different colors (see DIFFRACTION). Modern gratings are made by ruling straight grooves with a diamond on a glass surface or on a metal mirror. The gratings resemble the grooves on a phonograph record, but are much closer together. About 15,000 grooves per inch (5,910 grooves per centimeter) are common. The spectrum formed by a glass grating is seen by looking through it. JOSEPH VALASEK

See also GEISSLER TUBE; LIGHT (The Visible Spectrum); MASS SPECTROSCOPY; SIEGBAHN, KARL MANNE GEORG; SPECTROGRAPH.

THE SPECTROSCOPE—AN INSTRUMENT FOR SPECTRUM ANALYSIS



SPECTRUM. See Color (Color in Light); LIGHT (The Nature of Light); SPECTROSCOPE.

SPECTRUM, DIFFRACTION. See LIGHT (Diffraction).

SPECULAR IRON. See HEMATITE.

SPECULATION. See BOARD OF TRADE.

SPEECH has several definitions. It may mean the act of speaking, the result of speaking or what is spoken, the language of a nation or group of nations, or the dialect peculiar to a region or locality.

The act of speaking includes conversation, public speaking, debating, forum discussion, reading aloud, storytelling, and acting. It uses the *audible code* and the *visible code*, which are the sounds used by the speaker and the movements or gestures of his face, arms, and other parts of his body that are used for emphasis.

The result of speaking is the content and ideas expressed by the act of speaking. In formal speech, it includes the speech at the time it is given, and any written or printed form in which it may appear.

Language or dialect differs among peoples of various nations and groups of nations, and also within a nation. In the United States, the chief dialects are: (1) eastern (roughly, the New England states and New York City); (2) southern (roughly, the regions south of the Potomac and Ohio rivers [except West Virginia], most of Louisiana, and parts of Texas and Arkansas); and (3) general American (roughly, the rest of the United States).

The average child learns to speak by imitating the people around him. It is important that he hear proper speech. Parents should note any speech difficulties, such as lisping or stuttering, in their children. If such difficulties occur, parents should take the child to a competent authority on speech problems. Speech clinics can offer helpful advice. W. HAYES YEAGER

Related Articles in WORLD BOOK include:

Communication	Language	Speech Therapy
Conversation	Lisping	Stuttering and Stammering
Dialect	Pronunciation	
Handicapped (The Deaf)	Public Speaking	

SPEECH, FREEDOM OF. See FREEDOM OF SPEECH.

SPEECH THERAPY is the treatment of speech problems and disorders. Experts in the profession of speech therapy work with children and adults whose speech interferes with communication, calls attention to itself, and frustrates both speaker and listener. These specialists, called speech therapists, evaluate and correct defective speech and teach new speech skills. The field of speech therapy is often called speech pathology, and speech therapists are also known as speech pathologists or speech clinicians.

Types and Causes of Speech Defects. Speech therapists divide speech defects into five main types: (1) articulation problems, such as the inability to produce certain sounds; (2) stuttering, *cluttering* (rapid, slurred speech), and other fluency problems; (3) voice disorders, including problems of pitch, voice quality, and volume; (4) delayed speech, characterized by a child's slow language development; and (5) *aphasia*, the partial or total loss of the ability to speak or understand language.

About 6 per cent of the people in the United States have some kind of speech defect. Of that group, about 60 per cent have articulation problems, 12 per cent have fluency difficulties, and 8 per cent have voice disorders. The remaining 20 per cent have delayed speech, aphasia, or multiple speech problems.

Some speech defects result from a physical condition, such as brain damage, cleft palate, a disease of the larynx, or partial or complete deafness. Other speech defects may be caused by a person's environment. For example, a child who receives little encouragement to talk at home may not develop normal speech skills. Severe emotional conflicts, such as pressure to succeed or a lack of love, can also lead to speech difficulties.

Diagnosis. In many schools, speech therapists test students regularly for speech disorders. If a student has a speech problem, he receives therapy at the school, or he goes to a speech clinic for treatment. Many physicians, psychologists, and teachers refer people with speech defects to such clinics.

The speech therapist diagnoses the patient's speech problem and tries to learn its cause. He takes a detailed case history and gives the patient special speech and hearing tests. A patient may need medical or psychological treatment in addition to speech therapy.

Treatment. The speech therapist first gains the confidence of the patient. For the best results, the individual should enjoy being with the therapist and want to follow his instructions.

The method of treatment varies from case to case. The speech therapist must consider the age of the patient, his case history, the type of speech disorder, and the information gained about the patient during therapy. The therapist talks to the patient's family, teachers, and other persons who have close contact with him. The success of the treatment depends largely on the cooperation of these individuals.

Most children develop speech habits until about the age of 8. Thus, when working with a young patient, the therapist uses methods that help stimulate the development of good speech habits. With an older patient, the therapist must use corrective measures. First, he helps the patient to identify his speech problem and to tell the difference between his speech and normal speech. Many therapists use audio and video recording machines. A patient who mispronounces the "r" sound may be able to identify his error by listening to himself on a tape recorder and by watching the movement of his lips and tongue on a video screen. The therapist pronounces the sound correctly, and the patient hears and sees the difference. During the second stage of treatment, the therapist teaches the patient new speech skills. He may use tongue exercises and speech drills. After the patient has improved his speech, the therapist teaches him to use his skill in everyday situations.

Speech therapy may be given individually or in groups. The therapist puts patients in groups if he thinks that contact with people who have similar defects will bring rapid improvement. Many persons feel more at home and less self-conscious in a group than when alone with a therapist. They also receive encouragement by listening to others and by hearing the improvement of members of the group. Most patients with complex speech problems, such as aphasia, receive individual therapy. Speech specialists feel that individual attention in such cases achieves faster results than does group therapy. Some patients attend both kinds of sessions.

History. People have studied speech and speech problems for more than 2,000 years. However, little progress in the treatment of speech defects occurred until the 1700's and 1800's. During the 1700's, speech specialists worked mostly with the deaf. Successful teachers of the deaf included Thomas Braidwood, a Scottish mathematician. Braidwood taught his students to talk by starting with simple sounds and then progressing to syllables and, finally, words. The 1800's brought much research into the causes and treatment of stuttering. In 1817, Jean Marie Itard, a French physician, declared that stuttering resulted from a weakness of the tongue and larynx nerves. He recommended exercises to cure stutterers. During the late 1800's, Adolf Kussmaul, a German physician, wrote about the physical and psychological causes of stuttering. Today, speech therapists agree that there is no single cause of stuttering.

Speech therapy became a profession in the early 1900's. In Europe, it was associated with the medical profession. During the 1920's, schools for training speech therapists opened in several European countries. In the United States, speech therapy became closely allied with the fields of education, psychology, and speech. Several colleges opened speech clinics during the 1920's. The organization that became the American Speech and Hearing Association was founded in 1925.

During World War II (1939-1945), many servicemen developed speech defects as a result of war injuries. The need for speech rehabilitation services attracted large numbers of men and women to the profession of speech therapy. Many speech clinics opened, and research increased into speech problems and their causes. Since the end of World War II, the field of speech therapy has expanded rapidly.

Careers. Many universities offer undergraduate and graduate training in speech therapy. Men and women who plan a career in speech therapy should have a master's degree. Those who intend to teach in a college or university or to direct a clinic or research program should have a Ph.D.

Undergraduate students interested in speech therapy take courses in biology, linguistics, psychology, physics, introductory speech correction, and related fields. Graduate training covers five main areas: (1) development of speech, hearing, and language; (2) evaluation of speech production, language abilities, and auditory skills; (3) the nature of speech disorders; (4) treatment procedures; and (5) research techniques.

Most speech therapists work in schools. Others are employed by private institutions, including hospitals, rehabilitation centers, specialized community speech and hearing centers, and university speech clinics. Some therapists conduct research in private institutes. An increasing number of speech therapists are entering private practice. Further information about speech therapy can be obtained from the American Speech and Hearing Association, 9030 Old Georgetown Road, Washington, D.C. 20014.

HUGO H. GREGORY

See also CLEFT LIP; CLEFT PALATE; LISPING; SPEECH; STUTTERING AND STAMMERING; APHASIA.

SPEED. See METHAMPHETAMINE.

SPEED. See LIGHT (The Speed of Light); MOTION; SOUND (How Sound Travels); SPEEDOMETER; VELOCITY; AIRPLANE (Measuring Flying Speed).

SPEED READING is a skill designed to increase the amount of information obtained from material read within a certain period of time. Speed reading has enabled many readers of all ages to double the number of words per minute they can read.

Teachers may use various kinds of methods and machines to increase a person's reading rate. One machine flashes a series of words on a screen at increasing speeds. Another limits the time that the reader can spend on each line of words, according to the desired speed. However, reading speed often depends on (1) the difficulty of the reading material and (2) the purpose in reading it.

Many reading experts criticize speed-reading courses. These experts declare that the reading material used in the courses is too easy and that the comprehension tests are invalid.

STANLEY F. WANAT

SPEEDBALL is a team game that combines elements of soccer and basketball. It is usually played by 11-man teams on an outdoor field. The players advance the ball down the field by kicking it or passing it. They may also take one step while bouncing the ball, but they cannot run with it. Points are scored when a player kicks or drives the ball with his body through a goal post, when a player kicks the ball over the crossbar of the goal post, or when a player catches a pass behind the goal line.

See also BASKETBALL; SOCCER.

SPEEDOMETER, *spee DAHM uh tuhr*, is an instrument that indicates the speed of an automobile or other vehicle. The dial of a speedometer has numbers and a pointer to indicate the vehicle's speed. The speed is shown in miles per hour in American-built cars. Speedometers in many cars built in other countries show the speed in kilometers per hour (see KILOMETER).

A speedometer is powered by a flexible shaft that connects to a set of gears in the vehicle's transmission (see TRANSMISSION). The gears take into account the tire size and the axle ratio. When the vehicle moves, the gears in the transmission turn a core inside the shaft. The core is attached directly to a permanent magnet that lies near a *speedcup*. The revolving magnet sets up a rotating magnetic field that pulls the speedcup and its attached pointer in the same direction that the magnetic field is turning. A hairspring keeps the speedcup steady. The pointer on the speedcup comes to rest where the hairspring balances the force of the revolving magnet. When the vehicle stops, the hairspring pulls the pointer to zero. When the vehicle speeds up, the magnet increases its pull on the speedcup. This causes the speedometer to register a higher speed.

A device called an *odometer* registers the total distance traveled by a vehicle. Many speedometers have a *trip odometer* that can be reset to zero at the beginning of a trip. Manufacturers design speedometers so that 1,000 revolutions of the flexible shaft will register one mile on the odometer, and 1,000 revolutions a minute will indicate a speed of 60 miles an hour. Some speedometers run from a small electric generator. Speedometers require little care. But dirt and excess grease will make them inaccurate. They should be lubricated about every 10,000 miles. HERBERT O. VOGEL

See also PEDOMETER; TACHOMETER.

SPEEDWELL, the ship. See PLYMOUTH COLONY (The Founding of Plymouth Colony).

SPEEDWELL, weed. See FIGWORT FAMILY.

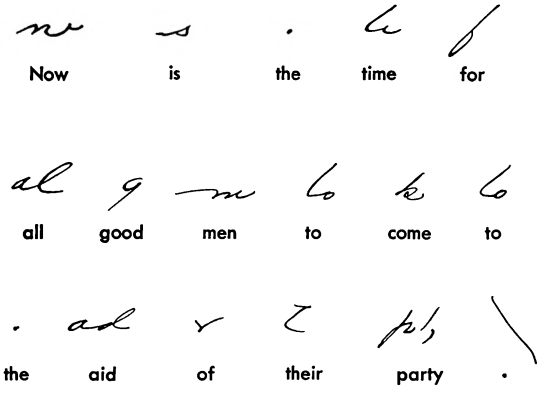
SPEEDWRITING is the registered trademark for a widely used shorthand system. It employs letters of the alphabet instead of symbols.

In Speedwriting shorthand, all words are written as they sound. Thus, *you* is written *u; are* is *r; eye* is *i*. In addition, a whole syllable may be represented by a letter or a punctuation mark. The letter *a* expresses the sound of *ate*. Thus, *late* is *la; bait* is *ba*. The letter *r* expresses the sound *re*. Thus, *rebate* is *rba*. A hyphen represents the final sound of *ment*. Thus, *pigment* is *pg-*.

Brief forms or abbreviations represent 218 frequently used words. All other words are written according to principle. For example, a secretary using Speedwriting writes the sentence, "*Your rebate check will reach you in a few days*," as:

u rba ck l rec u n a fu ds

The main advantage of Speedwriting shorthand is



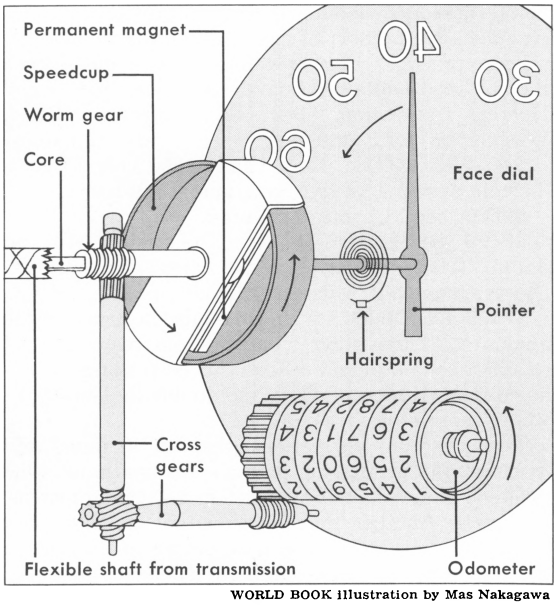
Speedwriting Uses the Alphabet and Standard Symbols.

that the student need not learn any new symbols. Therefore, he can take dictation at the rate of about 120 words per minute after only six to eight weeks of training. He can transcribe his notes rapidly and accurately because they are in his regular handwriting.

Emma B. Dearborn, a shorthand teacher of Darien, Conn., originated Speedwriting in 1923. PAUL M. PAIR

See also SHORTHAND (introduction); SHORTHAND MACHINE.

SPEIDEL, *SPY dul*, **HANS** (1895-), a German general, served in World War II and became a leader in the postwar West German Army. As chief of staff to



WORLD BOOK illustration by Mas Nakagawa

A Speedometer shows the speed of a vehicle. As the vehicle moves, gears in its transmission turn a core inside a flexible shaft. The core turns a permanent magnet to which it is attached. The magnet rotates a speedcup and pointer on the speedometer dial. The pointer stops when a hairspring balances the force of the magnet. An odometer registers the total distance traveled.

Field Marshal Erwin Rommel in France in 1944, he united the efforts of the German officers fighting against Adolf Hitler. He was important in the series of unsuccessful plots to rid Germany of Hitler. He became commander of the North Atlantic Treaty Organization (NATO) ground forces in Central Europe in 1957. Speidel was born in Metzingen, Württemberg. LESTER B. MASON

SPEKE, JOHN HANNING. See EXPLORATION AND DISCOVERY (table: Explorers of Africa); BURTON, SIR RICHARD FRANCIS; AFRICA (picture); LAKE VICTORIA.

SPELEOLOGY is the scientific study of caves. Scientists who make such studies are called *speleologists*. Persons who explore and map caves as a hobby are called *spelunkers*. Many cave explorers belong to the National Speleological Society. See also CAVE.

SPELL. See MAGIC (Magic Words).

SPELLING is the way we combine letters to write words. Learning to spell correctly is part of learning a language. The English language has only 26 letters. But the several hundred thousand words of the English language can all be spelled with these 26 letters. Correct spelling, like correct speaking, is more than a sign of a person's education. It helps him communicate his thoughts in writing so others will know quickly and easily what he means to say.

To understand how the alphabet works, say out loud the word *bat*. Say the word again, and listen carefully for the three sounds that blend together to make up the spoken word. Now, write the word instead of saying it. First, write the letter that stands for the beginning sound of the word, *b*. Next, write the letter that stands for the middle sound, *a*. Last, write the letter that stands for the final sound, *t*. The letters *b-a-t* repeat in the same order the three original sounds of the spoken word. This is the *spelling* of the word *bat*. Spelling is simply the method of writing letters for spoken sounds. But the historical development of the English language has resulted in many spellings that do not follow the way the words are pronounced.

Learning to Spell

Many persons make spelling more difficult than is necessary. They try to learn their spelling by speaking, as in spelldowns, and forget that writing is the only place in which spelling can possibly matter. They spend time and effort on words that they are unlikely ever to write and whose meanings are vague to them. They emphasize spelling drill and spelling rules, but neglect to work out an effective method of learning to spell new words. They try to learn spelling without developing any interest in the magic of words and the ways people use language to communicate ideas.

Base Words. The first problem in learning to spell is to decide which words are the most important. The average person uses fewer than 25,000 words in speaking. He uses even fewer in writing. About 2,000 *base words* will satisfy over 90 per cent of the writing needs of the average eighth-grade student. An additional 1,000 base words, or 3,000 in all, will take care of 95 per cent of the writing needs of the average adult. An example of a base word is *danger*. Some words that come from this base include *dangerous* and *endanger*.

The student should first learn to spell the 3,000 base words. Then he can add the spellings of words that he uses for personal or business reasons. There are two main sources for base words. One is the writing of adults and the other is the writing of children. Many words occur in both groups. Most spelling textbooks include lists of words of both groups.

Thousands of words have been studied to make up the lists of base words. For example, *about* is used by adults and by children as early as the first grade. *Absorb* is used by adults, but is seldom used by children until the eighth grade. *Abrupt* is often used by adults, but is seldom used by young people before high school.

Methods of Study. The difference between good spellers and poor spellers can often be traced to one problem: finding an effective *method* of learning to spell. Good spellers have some method for studying words they want to spell. Poor spellers are frequently helpless with a new word. When they try to learn a new spelling, they usually use poor methods. Here are 10 common steps used by good spellers:

1. Looking at the word.
2. Copying the word.
3. Remembering how the word looks.
4. Listening to the pronunciation of the word.
5. Pronouncing the word.
6. Dividing the word into syllables.
7. Saying the letters of the word in order.
8. Writing the word to get its "feel."
9. Studying the difficult parts of the word.
10. Using the word in a meaningful sentence.

Remembering trick phrases, such as "the princi*pal* is a *pal*," is not a good substitute for an effective learning method. A few spelling tricks, such as remembering "station*ery*" with "pa*per*," may be helpful with some particularly hard word. But too many special tricks can be confusing.

A person who wants to improve his spelling can make a combination of the steps listed above that suits him. Few people would use all 10 steps. Once the combination has been selected, it should be tested and changed if necessary. Then the combination can become a regular part of a person's learning habits. Visualizing the word, or remembering how it looks, should probably be part of everyone's combination. Here is a combination suggested by an authority on spelling:

1. Understand the use, meaning, and pronunciation of the word.
2. Visualize the word.
3. Note the spelling of the word.
4. Write the word carefully and neatly.
5. Check the spelling of the word.
6. Use the word as often as possible in writing.

This combination may not be best for some persons, but it should be useful for most beginners.

Spelling Rules can help improve a person's spelling. Use these rules with great care, because there are often many exceptions.

Many words come from a base word. For example, the words derived from *develop* include *develops*, *developed*, *development*, *developing*, and *developer*. Each of these new forms is made with a *suffix* added at the end of a word. Here are some rules that help people spell suffixes correctly:

1. Drop the final *e* in a word before a suffix beginning with a vowel. For example, *love* + *ing* is *loving*. An exception is *dyeing*.

200 SPELLING DEMONS

absence	benefit	eighth	height	necessary	raise	surgeon
absorption	bicycle	eminent	heinous	night	receipt	sympathize
accommodate	boundary	enough	history	ninth	receive	temperament
ache	bulletin	envelope	hoarse	noticeable	referred	temporary
acquaintance	burglar	everything	hour	occasion	reign	therefore
acquitted	business	exceed	illiterate	occurrence	repeat	tragedy
across	cafeteria	existence	immediately	often	repetition	typical
affidavit	ceiling	expedition	indictment	omitted	rescind	until
again	cemetery	expense	indispensable	optimistic	reservoir	vacuum
aggravate	chauffeur	extraordinary	innocent	origin	restaurant	vegetable
aghast	chocolate	familiar	interfere	original	rheumatism	vengeance
all right	colonel	fascinate	introduce	pageant	rhyme	warrant
ally	column	fasten	laboratory	parliament	ridiculous	wear
already	coming	February	legitimate	perform	sacrifice	week
always	commercial	forfeit	leisure	permanent	schedule	weird
among	committee	forty	library	perseverance	secretary	whether
analysis	confidence	friend	license	picnicking	seize	which
analyze	control	fulfill	literature	pleasant	semester	whole
angel	controversy	genius	magnificent	pneumonia	separate	women
angle	convertible	government	maneuver	possessive	siege	won't
annual	counterfeit	governor	mathematics	prairie	skein	would
answer	courteous	grammar	meant	prejudice	sophomore	writer
appetite	curiosity	gratified	medal	principal	specimen	writing
arctic	dealt	guarantee	millionaire	principle	stationery	written
ascent	desperate	guerrilla	miniature	professor	statistics	wrote
awkward	despise	guess	minute	pursue	strictly	yacht
bachelor	develop	handsome	mortgage	quantity	succeed	
beggar	discipline	hangar	muscle	quiet	sugar	
believe	doctor	harass	mystery	quite	superintendent	

2. Keep the final *e* in a word before a suffix beginning with a consonant. For example, *sure* + *ly* is *surely*.

3. When a word ends in *y* preceded by a consonant, change the *y* to *i* before adding a suffix (unless the suffix begins with *i*). For example, *plenty* + *ful* is *plentiful*.

4. When a one-syllable word ends in a consonant preceded by a single vowel, double the consonant before a suffix beginning with a vowel. For example, *run* + *er* becomes *runner*.

5. When a word has more than one syllable, double the consonant only if the accent of the word is on the last syllable. For example, *admit'* + *ed* is *admitted*.

Prefixes are added to the beginning of words. Three common prefixes are *dis-*, *mis-*, and *un-*. When they are added to a word beginning with the same letter, there will be two *s*'s or *n*'s. For example, *mis* + *spell* is *misspell*. When they are added to a word beginning with a different letter, there will be only one *n* or *s*. For example, *un* + *willing* is *unwilling*.

One of the biggest spelling problems comes from the use of *ei* and *ie*. Some words are spelled with *ei*, such as *receive*. Some words are spelled with *ie*, such as *believe*. A spelling rule to remember is: "Use *i* before *e* except after *c* or when it is sounded like *a*, as in *neighbor* and *weigh*." Exceptions to this rule include *either* and *seize*.

Adding New Words

One way a person can increase the number of words he can spell is to learn the spelling of words derived from a base word. For example, *trust* is a base word. A number of words, such as *mistrust*, *trusting*, and *trustee*, come from this base word. A similar method is to learn the *root meanings* of words. The root of a word is its basic form. For example, the root *port* means *carry*. Knowing this helps to learn the spelling and meaning of such words as *portage*, *import*, *export*, *report*, *porter*, *deport*, *portable*, *comportment*, and *portfolio*.

A more important way of adding new words is to learn the habit of using a dictionary. On seeing a new word, look it up in the dictionary and study its spelling and pronunciation. The dictionary also gives root meanings of words. See DICTIONARY.

Sometimes a word has two or more different spellings. For example, *enrollment* and *enrolment* are both correct spellings. Usually, a dictionary gives the *preferred spelling* first. But this does not mean that the alternate spelling is wrong. There are also many differences between American and British spellings. For example, the American *labor* is the British *labour*. The American *center* is the British *centre*. And the American spelling *connection* is the British *connexion*.

Spelling Demons

Words that people find unusually difficult to spell are called *spelling demons*. They often have an irregular arrangement of letters and need special study. The word *fasten* is a typical spelling demon. Many people who misspell this word write it *fasen*, because the *t* is silent. That is, a person does not sound the *t* in *fasten* when he speaks the word. Another demon is *friend*. People often write it *freind*, because the word has the sound of *e*.

Many spelling demons are *homonyms*, or words that sound alike but have different meanings. For example, *pray* and *prey* are often misspelled because they sound alike. Other homonyms include *bare* and *bear*, *principal* and *principle*, *read* and *red*, and *to*, *too*, and *two*. Failing to pronounce a word accurately and distinctly is a frequent cause of error. The word *government* is an example. If a person says *gov-er-ment*, he may spell the word without the first *n*. Two other examples are *preform* for *perform* and *quanity* for *quantity*.

Simplified Spelling

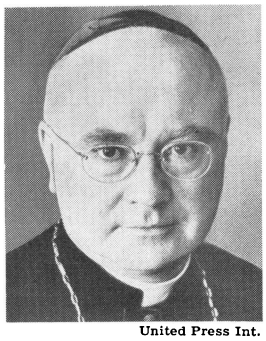
Many attempts have been made to simplify the spelling of the English language. The aim of most of these

plans is to spell a word exactly as it is pronounced. For example, under these plans the word *though* would be spelled *tho*, and the word *knock* would be spelled *nok*.

There have been two chief arguments against such changes. The first is that simplified spelling would destroy the familiar pattern of words and cause confusion. The second is that the pronunciation of words changes continuously. Changes in pronunciation can occur rapidly or slowly. Words would soon become unrecognizable if the spelling were changed to meet each new change in pronunciation. WALTER LOBAN

See also ABBREVIATION; ALPHABET.

SPELLMAN, FRANCIS CARDINAL (1889-1967), was one of the outstanding leaders of the Roman Catholic Church in the United States. His wide acquaintance among church officials throughout the world made his services valuable in special missions for both Presidents Franklin D. Roosevelt and Harry S. Truman. Spellman served as apostolic vicar to the United States armed forces, and made several trips to various battle areas during time of war. Pope Pius XII named him a cardinal in 1946.



United Press Int.
Cardinal Spellman

Spellman was born at Whitman, Mass. He took his college degree at Fordham University, and was ordained a priest in 1916 after studying at the North American College in Rome. His first post was in Boston. From 1925 to 1932 he was in the service of the Papal Secretariat in Rome. He was consecrated a bishop in Rome, and returned to serve as auxiliary bishop of Boston. In 1939, Pope Pius XI named him archbishop of the see of New York. FULTON J. SHEEN

SPELMAN COLLEGE. See UNIVERSITIES AND COLLEGES (table).

SPELUNKER. See SPELEOLOGY.

SPEMANN, *SHPAY mahn*, **HANS** (1869-1941), a German biologist, pioneered in the analysis of embryonic development. Through novel, delicate grafting experiments performed on frog and newt embryos, Spemann discovered *organizers*. These are organ-forming influences exerted on tissues by neighboring embryo parts. He showed that the lens of the eye, for example, is induced to develop by the underlying eye-cup. He won the 1935 Nobel prize for physiology and medicine. Spemann was born in Stuttgart. MORDECAI L. GABRIEL

SPENCER, ANNA GARLIN (1851-1931), was an American reformer, minister, and educator. She supported women's rights, and became active in groups that worked to give women the right to vote. Her book *Woman's Share in Social Culture* (1913) helped call public attention to the ways society can benefit from men and women working together. She also worked to promote world peace, to ban the sale of liquor, and to strengthen family life.

Anna Garlin was born in Attleboro, Mass. She married William H. Spencer, a Unitarian minister, in 1878. In 1891, she became minister of the Bell Street Chapel in Providence, R.I. She was the state's first woman minister. She later served as associate director of the New York School of Philanthropy, and taught sociology at several universities. LOUIS FILLER

See also WOMAN SUFFRAGE.

SPENCER, HERBERT (1820-1903), was a British philosopher. He is noted for his attempt to work out a philosophy, based on the scientific discoveries of his day, which could be applied to all subjects. In his great work *Programme of a System of Synthetic Philosophy* (1862-1896), Spencer applied his fundamental law—the idea of *evolution* (gradual development)—to biology, psychology, sociology, and other fields.

In his work on biology, Spencer traced the development of life from its lowest recognizable form up to man. He believed that the great law of nature is the constant action of forces which tend to change all forms from the simple to the complex. Spencer explained that the mind of man has developed in this same way, advancing from the simple automatic responses of lower animals to the reasoning processes of thinking man.

Spencer claimed that knowledge was of two kinds: (1) knowledge gained by the individual, and (2) knowledge gained by the race. He said that intuition, or knowledge learned unconsciously, was the inherited knowledge or experience of the race.

Spencer was born in Derby on April 27, 1820. He was a delicate child. His first interest was biology, but he later turned to engineering. From 1837 to 1846, he worked as an engineer for the London and Birmingham Railway. Later he served as editor of the *Economist*. Spencer left the *Economist* in 1853 to write *Synthetic Philosophy*. He gained a wide reputation as a philosopher, but scientists later proved many of his theories wrong. EUGENE ADAMS

SPENCERIAN WRITING. See HANDWRITING (Later Writing Styles).

SPENDER, STEPHEN (1909-), is an English poet. His best-known poetry is a blend of traditional romanticism and thoroughly modern subject matter and attitudes. Thus, he finds in an express train the sort of beauty earlier romantic poets found in waterfalls and sunsets. In "The Express," he wrote:

Ah, like a comet through flame, she moves entranced,
Wrapt in her music no bird song, no, nor bough
Breaking with honey buds, shall ever equal.*

Much of Spender's poetry expresses his radical political views and his compassion for what he sees as the victims of capitalism, such as the children of the poor.

Spender was born in London. He attended Oxford University, and there gained recognition in the 1930's as one of a group of poets led by his friend W. H. Auden. Spender's *Collected Poems* were published in 1954. He also wrote criticism, drama, fiction, translations, and the autobiography *World Within World* (1951). TIM REYNOLDS

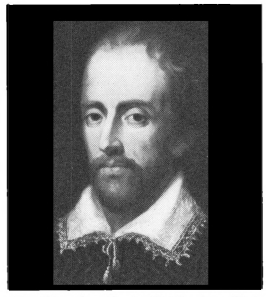
* Lines from "The Express" from COLLECTED POEMS 1928-1953 STEPHEN SPENDER, copyright 1955 by Stephen Spender, courtesy Random House, Inc., and Faber & Faber, Ltd.

SPENGLER, *SHPENG lur*, **OSWALD** (1880-1936), was a German philosopher of history. In *The Decline of the West* (1918-1922), he held that the key to history is the law of societies and civilizations, which rise and fall in cycles. Using speculation and insight rather than rigid

historical method, he concluded that Western civilization was in a period of decay. Spengler was born in Blankenburg. MERLE CURTI

See also CIVILIZATION (Theories About Civilization).

SPENSER, EDMUND (1552?-1599), was a great Elizabethan poet. His epic poem, *The Faerie Queene*, though never finished, is a masterpiece of English literature. Spenser completed only 6 of the 12 *books* (sections) he planned for this work.



Detail of oil portrait by Benjamin Wilson, Pembroke College, Cambridge, England

Edmund Spenser

Spenser's Life. Spenser was born in London. He entered Cambridge University in 1569, and received a B.A. degree in 1573 and an M.A. degree in 1576. At Cambridge, he received a strong background in the classics. He also was influenced there by the anti-Roman Catholic feelings and stern moral beliefs of the Puritans. These influences were later reflected in Spenser's poems. In all his works, he effectively blended themes of paganism with moralistic teachings, and revealed his strong English patriotic feelings. At Cambridge, Spenser became the friend of Gabriel Harvey, one of England's intellectual leaders. Harvey introduced Spenser to the author and courtier Sir Philip Sidney, and both encouraged Spenser in his early writings. Most of these works have disappeared.

In 1580, Spenser became secretary to Lord Grey of Wilton, the governor of Ireland. From 1580 until a month before his death, Spenser visited England only twice, to supervise publication of *The Faerie Queene*.

Frequent Irish insurrections against English rule kept Spenser so busy that he needed 10 years to write the first three books of *The Faerie Queene*. These books were published in 1590. Spenser dedicated them to Queen Elizabeth, who awarded him a yearly pension.

In 1594, Spenser married Elizabeth Boyle, the daughter of an Irish landowner. They had four children. The second three books of *The Faerie Queene* appeared in 1596. Spenser was appointed sheriff of Cork in 1598, and late that year was sent to England with reports on the Irish uprisings. He became ill in London and died on Jan. 13, 1599.

The Faerie Queene is set in a fairyland, but the characters are realistic. This *allegorical* (symbolic) work is filled with interesting events and scenes of rural Irish life. In writing *The Faerie Queene*, Spenser was influenced by the works of the English poet Geoffrey Chaucer and two Italian epics of the 1500's, Ludovico Ariosto's *Orlando Furioso* and Torquato Tasso's *Jerusalem Delivered*. *The Faerie Queene* also shows the qualities a gentleman should have, reflecting the tradition of the *courtesy book*. The main character in each of the six books gradually develops a desired virtue—holiness, temperance, chastity, friendship, justice, or courtesy. Spenser included both moral and political allegory in *The Faerie Queene*. He wrote in a distinctive pattern, now called the *Spenserian stanza*, consisting of eight pentameter lines followed by an alexandrine (see POETRY [table: Terms Used in Poetry]).

Spenser's Other Poems. Spenser's first major poem, *The Shepheardes Calender* (1579), immediately made his reputation. It consists of 12 *eclogues* (short poems about country life written as dialogues between shepherds). *Colin Clouts Come Home Againe* (1595) shows Spenser's disillusionment with London court life after a visit to England. *Amoretti* (1595) is Spenser's famous *cycle* (series) of 89 love sonnets. *Epithalamion* (1595) has been called literature's greatest poem about marriage. It describes 20 hours in an Irish wedding day, and is a blend of classical and Christian traditions and Irish folklore. THOMAS A. ERHARD

SPERM. See REPRODUCTION.

SPERM WHALE, or CACHALOT, is probably the best known kind of whale. It became famous in the novel *Moby-Dick* by Herman Melville. During the greatest period of U.S. whaling, from the 1830's to the 1860's, Americans hunted sperm whales more than any other kind.

The sperm whale is found in all the oceans. It grows as long as 65 feet (20 meters) and weighs up to 60 short tons (54 metric tons). The huge head makes up a third of the sperm whale's body. The head contains a reservoir of *spermaceti*, a valuable waxy material. *Sperm oil* comes from the head and from the blubber. Another waxy substance, *ambergris*, is found in the intestines of some sperm whales.

Scientific Classification. The sperm whale belongs to the sperm-whale family, *Physeteridae*. It is genus *Physeter*, species *P. catodon*. RAYMOND M. GILMORE

See also WHALE; SPERMACETI; AMBERGRIS.

SPERMACETI, *SPUR muh SEE tee*, is a waxy material obtained from the enormous head of the sperm whale. The blubber of the sperm whale also contains some of this substance. Spermaceti is used as an ingredient of some salves and face creams. It once was used to make candles. Manufacturers use sperm oil to lubricate machinery and to soften leather. Some spermaceti comes from the bottle-nosed whale and the giant bottle-nosed whale. Spermaceti probably has a function for whales, but no one knows what it is. See also SPERM WHALE. RAYMOND M. GILMORE

SPERMATOZOA. See FERTILIZATION.

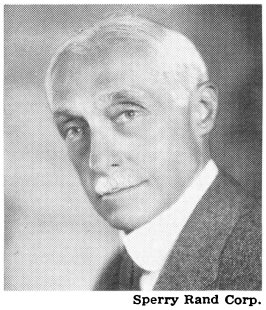
SPERRY, ARMSTRONG (1897-), is an American author and illustrator of children's books. Sperry's interest in the sea began in boyhood, and his great-grandfather told him yarns of his adventures as a sea captain in the South Seas. In 1941, Sperry won the Newbery medal for *Call It Courage* (1940).

Sperry was born in New Haven, Conn., and attended the Yale Art School. Later, he studied art in New York City. Sperry lived in the South Pacific for two years. EVELYN RAY SICKELS

SPERRY, ELMER AMBROSE (1860-1930), was an American scientist, inventor, and manufacturer. He is best known for his development of the gyroscope for use in navigation (see GYROSCOPE). Sperry's enterprises included the manufacture of arc lamps in Chicago, of electric railways in Cleveland, Ohio, and gyroscopes in New York City.

Sperry was born in Cortland, N.Y. He studied at the State Normal and Training School and at Cornell University. While still in college, he attracted attention by

building an arc lamp with a dynamo to run it. The lamp was much more efficient than any other then used for street lighting, and at the age of 19 Sperry set up his first factory in the city of Chicago where he produced his lamps. Forty years later he returned to the field of lighting and developed the powerful beacon and searchlights later used by many armies and navies. In the meantime, he also developed electrically driven mining equipment, automobiles, and streetcars.



Sperry Rand Corp.
Elmer Sperry

Sperry first used the gyroscope in 1911 to develop a new kind of compass for ships. The increase in the amount of steel used in shipbuilding had made magnetic compasses unreliable. Sperry's gyrocompass successfully solved this problem (see GYROCOMPASS). The gyroscopic stabilizer for aircraft, devised with his son Lawrence, was successfully demonstrated in 1914. From his gyrocompass, Sperry developed the gyropilot which steers a ship automatically (see GYROPILOT). Later he installed giant gyroscopes which could steady the rolling motions of ships. After the United States entered World War I, Sperry developed a number of important instruments for gun control. These inventions increased the effectiveness and range of gunfire and torpedoes. He also produced an aerial torpedo controlled by a gyroscope.

Today's naval gunnery methods would be impossible without the inventions which grew out of Sperry's original gyroscope. During World War II it was adapted for use in many complex military instruments, such as naval gunsights. His inventions were equally important for use in navigating aircraft (see AIRCRAFT INSTRUMENTS).

RICHARD D. HUMPHREY

SPERTUS COLLEGE OF JUDAICA. See UNIVERSITIES AND COLLEGES (table).

SPEYER, DIET OF. See PROTESTANTISM.

SPHAGNUM MOSS. See PEAT MOSS.

SPHALERITE. See ZINC.

SPHENOID BONE. See HEAD.

SPHERE, *sfeer*, is a solid figure that resembles a ball or globe. The name *sphere* comes from a Greek word that means *ball*. In geometry, mathematicians define a sphere as the location in space of all points a certain distance from a fixed point called the *center*. This means that a sphere is a solid figure bounded by a single surface. The surface itself does not have any edges or boundaries. Each point on the surface is the same distance from the center.

Parts. The *radius* of a sphere is the distance from the center to the surface. Or, the radius is any straight line drawn from the center to the surface. The *diameter* of a sphere is twice the radius. Or, the diameter is any straight line, drawn through the center, whose ends stop at the surface. A *secant* is any line that cuts through a sphere. A *chord* is any line that joins two points on the sphere.

If a *plane*, or flat surface, passes through the center of a sphere, the plane produces a *great circle* of the sphere. The radius and diameter of a great circle are the same as the radius and diameter of the sphere. A great circle cuts a sphere in half. Each half of the sphere is called a *hemisphere*.

Finding the Surface. Here is a formula which you can use for finding the area of the surface of a sphere:

$$\textbf{Surface} = 4\pi r^2$$

In the formula, the letter r stands for the radius. A convenient value for π is 3.1416. The surface computed with this formula will appear in square units of measure; for example, in square inches or square centimeters.

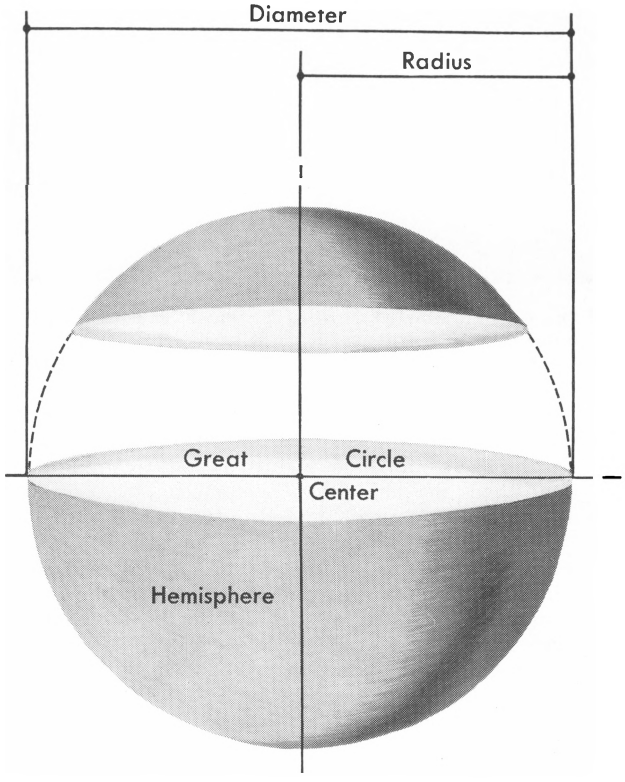
Finding the Volume. Here is the formula for finding the volume of a sphere:

$$\textbf{Volume} = \tfrac{4}{3}\pi r^3$$

The letter r stands for the radius. The volume computed with this formula will appear in cubic units; for example, in cubic inches or cubic centimeters.

See also CIRCLE; GEOMETRY (Solid Geometry).

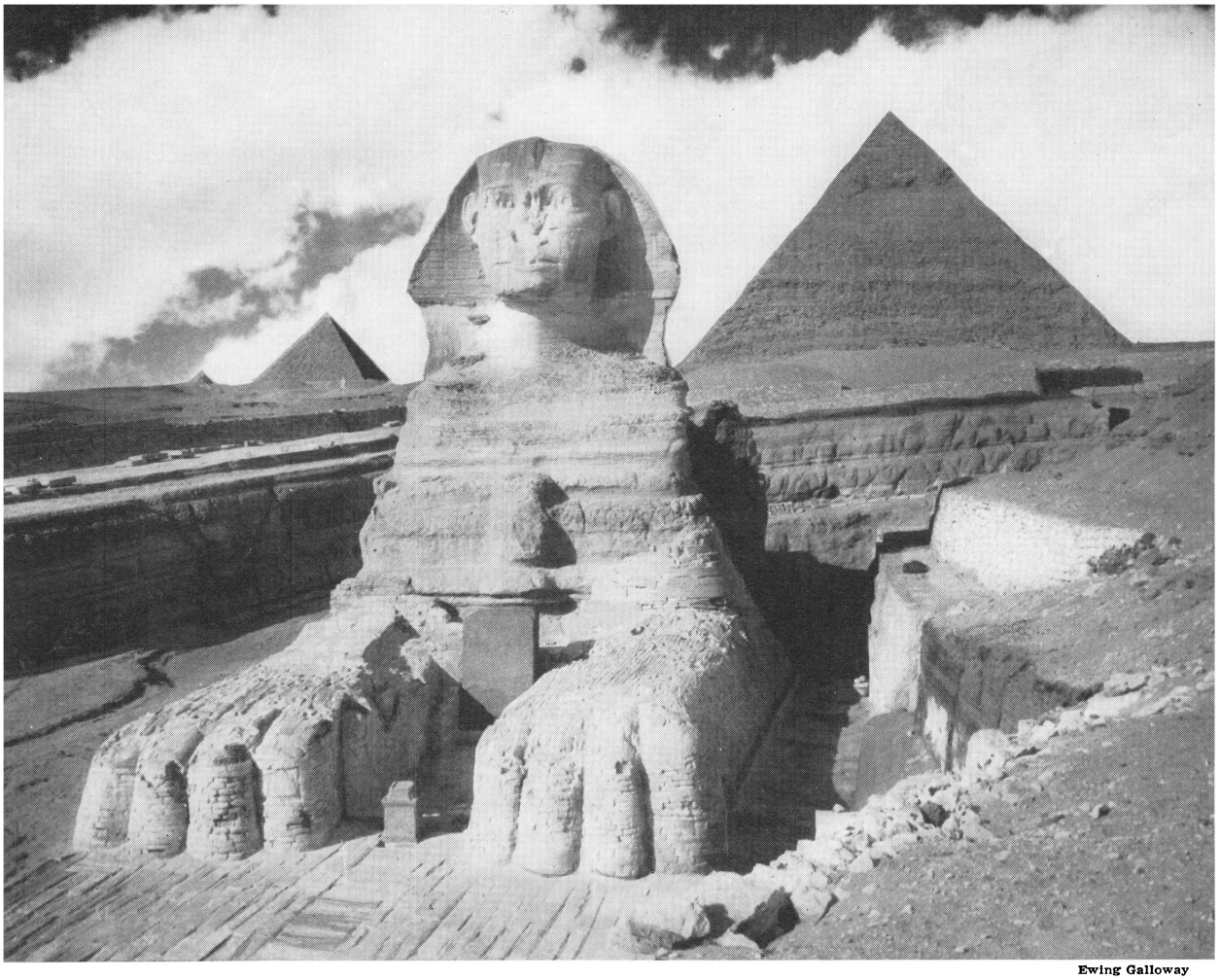
PARTS OF A SPHERE



SPHEROID is a solid figure that resembles a sphere. It is not perfectly round. The earth is an *oblate* spheroid. It is wider than it is long. A football is a *prolate* spheroid. It is longer than it is wide.

SPHINCTER, *SFINGK tur*, is a circle of muscle surrounding a body tube. The muscle usually is found near the outlet of the tube. It may be a voluntary or involuntary muscle. The *pyloric sphincter* regulates the flow of food from the stomach into the small intestine. See also MUSCLE.

CARL C. FRANCIS



Ewing Galloway

The Great Sphinx at Giza, Egypt, stares with sightless eyes across the desert, as it has for about 4,500 years. The photograph was made after the lower part of the great statue had been uncovered by scientists in 1926. The forefeet are made of huge pieces of stone masonry. In the background are three pyramids—once tombs of Egyptian rulers.

SPHINX, *sfinks*, is an imaginary creature of ancient myths. The Egyptians, Greeks, and peoples of the Near East all had stories about such creatures. According to some stories, the sphinx had a human head, the body of a lion, the tail of a serpent, and the wings of a bird.

The Egyptian Sphinx usually had the head of a man, and the body, legs, feet, and tail of a lion. It had no wings. The sphinx was supposed to represent the god Horus, who guarded temples and tombs. Egyptians made many statues of sphinxes. When Egyptian sculptors made such a statue, they usually made its face resemble the Pharaoh of the time. But some of the statues had heads resembling those of rams and hawks. The Egyptians often lined both sides of avenues with sphinx statues, as in the great temple at Karnak.

The Greek Sphinx usually had the head of a woman. In Greek literature, the sphinx lived on a high rock outside the city of Thebes. When anyone passed by, she asked him a riddle: What has one voice and yet becomes four-footed and two-footed and three-footed? If the traveler could not give the right answer, the sphinx ate him.

When Oedipus passed by on his way to Thebes, the sphinx asked him the riddle. Oedipus replied that the answer was man, because man walks on his hands and feet when he is young, on two feet in the middle of his life, and with a cane or staff in his old age. The sphinx became furious because Oedipus had given the right answer. She howled with rage, and finally threw herself from the rock to her death.

The Great Sphinx that stands at Giza, near the Great Pyramid in Egypt, is one of the most famous monuments in the world. Its head and body are carved from solid rock, and the paws and legs are built of stone blocks. The face is believed to be a portrait of the Egyptian king who built it. No one knows exactly which king built the Sphinx.

The Great Sphinx is 240 feet (73 meters) long and about 66 feet (20 meters) high. The width of its face measures 13 feet 8 inches (4.17 meters). The head has been used as a gunnery target, and desert sands have worn away part of the stone.

Sand covers the base of the Sphinx, and buries it most of the time. Thutmose IV of Egypt cleared it away in the 1400's B.C., and one of the Ptolemies cleared it during Roman times. The sand was cleared away again in 1818, 1886, and 1926. HOWARD M. DAVIS

See also OEDIPUS.

SPHINX MOTH. See HAWK MOTH.

SPHYGMOMANOMETER. See BLOOD PRESSURE.

SPICA, *SPY kuh,* is a star of the first magnitude in the constellation Virgo. This blue star gives off the light of 2,440 suns. However, Spica is so far away from earth that it takes this light 300 years to reach us. The name *Spica* means *ear of wheat.*

See also VIRGO.

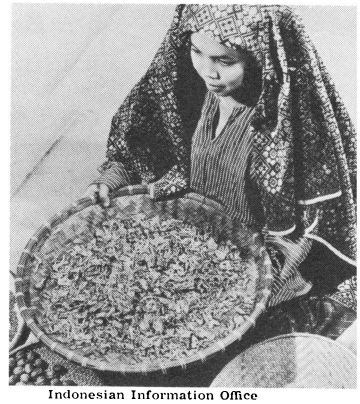
SPICE is the name given to food seasonings made from plants. Spices have a sharp taste and odor. Some spices are valued for their taste, and others for their smell. Common spices include pepper, nutmeg, cloves, ginger, allspice, mace, mustard, and cinnamon.

Spices have little in common except their use. They come from different parts of the various spice plants. For example, cloves come from the bud, cinnamon from the bark, and pepper and nutmeg from the fruit of each plant. Ginger comes from the root and mustard from the seed. Curry, a seasoning made from a combination of spices, is widely used in India.

Spice plants grow in many tropical countries. The Moluccas, or Spice Islands, are a famous source of spices (see MOLUCCAS). Many persons prefer to grow spice plants such as sage, marjoram, thyme, and others in their own gardens. They then dry the plants for later use. Some common spice plants grow indoors if they are placed in pots in sunny windows.

Spices have little food value. But they do increase the appetite and stimulate the organs of digestion. Spices must not be used too generously, for they can sometimes be harmful to the body. Before foods were refrigerated or canned, spices were used to make tainted foods taste better.

Spices have played an important part in history. The cities of Genoa and Venice became powerful because they were at the center of the spice trade with the East. When Columbus and the early explorers set sail across unknown seas, they were interested in discovering an all-water route to the spice lands of the East. Merchants made great profits in the early days of the spice trade. Even in modern times, spices are important to us. During World War II, for example, many of the East Indian sources of spice were temporarily destroyed. As a result, pepper supplies in the U.S. dwindled sharply, and many Americans often had to do without food seasoning. HAROLD NORMAN MOLDENKE



Indonesian Information Office

A Javanese Spice Seller offers a basket of dried mace at the marketplace.

Related Articles in WORLD BOOK include:

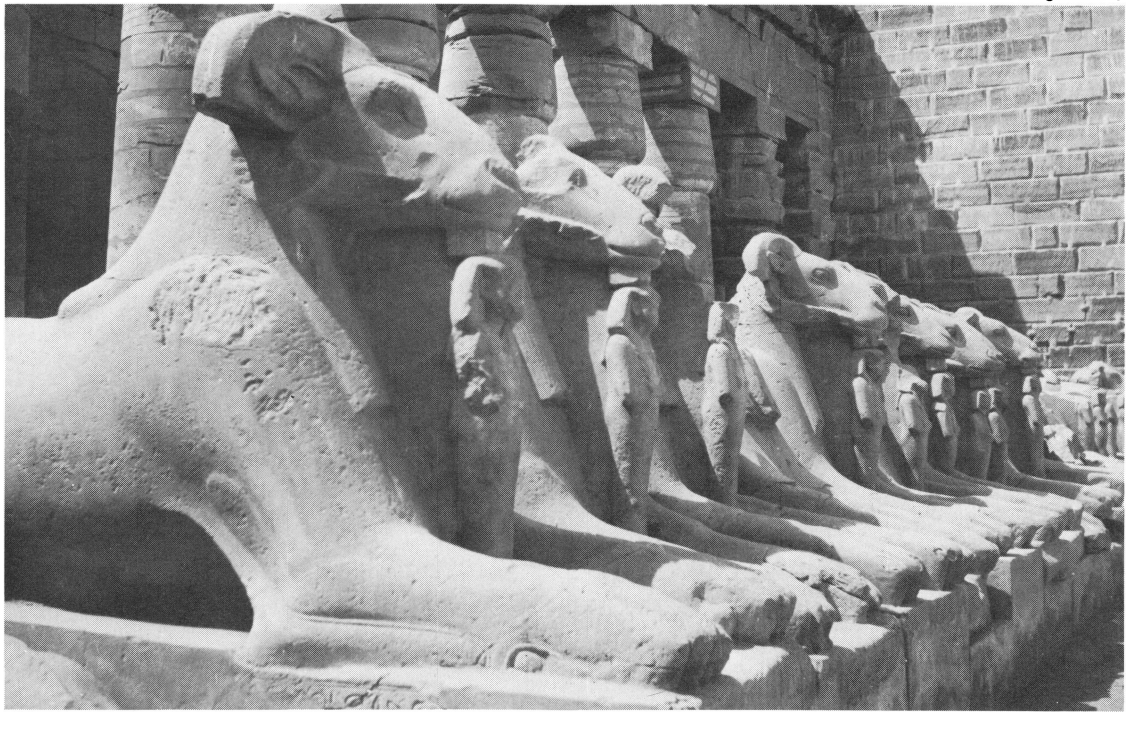
Allspice	Clove	Marjoram
Anise	Coriander	Mustard
Caper	Cubeb	Nutmeg
Capsicum	Curry	Paprika
Caraway	Dill	Pepper
Cardamom	Fennel	Sage
Cayenne Pepper	Ginger	Thyme
Cinnamon	Mace	Turmeric

SPICE ISLANDS. See MOLUCCAS.

SPICULE. See SPONGE (The Body of the Sponge).

Avenue of Sphinxes leads to the Great Temple of Amon-Re at Karnak, on the east bank of the Nile River near what is now Luxor, Egypt. King Amenhotep III built the sphinxes about 1400 B.C.

Ewing Galloway



SPIDER

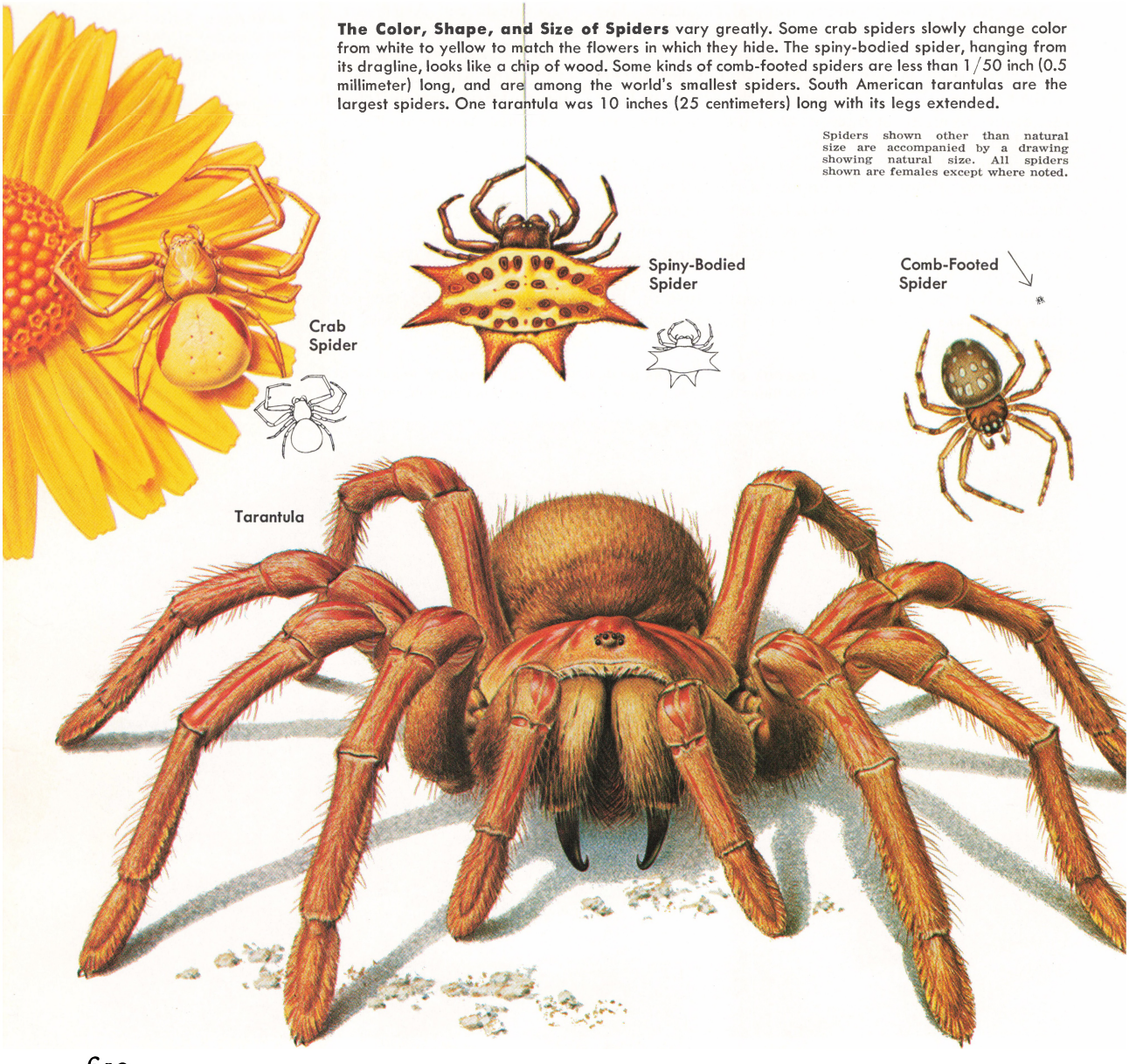
SPIDER is a small, eight-legged animal that spins silk. Spiders are best known for the silk webs they spin. They use their webs to catch insects for food. Even insects that are larger and stronger than spiders cannot escape from the threads of a spider's web.

All spiders spin silk, but some kinds of spiders do not make webs. The bolas spider, for example, spins a single line of silk with a drop of sticky silk at the end. When an insect flies near, this spider swings the line at it and traps the insect in the sticky ball.

All spiders have fangs, and most kinds of spiders have poison glands. A spider's bite can kill insects and other small animals, but few kinds of spiders are harmful to man. In North America, only six kinds of spiders have bites that can harm man. These spiders are the brown recluse spider, the sack spider, the black widow, the brown widow, the red-legged widow, and the varied widow. Of the four "widow" spiders, only the females are known to bite man. Many persons are afraid of spiders. But only hurt or frightened spiders bite human beings.

Spiders are helpful to man because they eat harmful insects. Spiders eat grasshoppers and locusts, which destroy man's crops, and flies and mosquitoes, which carry diseases. Some large spiders eat such animals as mice, birds, lizards, frogs, and fish. Spiders even eat each other. Most female spiders are larger and stronger than male spiders, and often eat the males.

Spiders live anywhere they can find food. They can be seen in fields, woods, swamps, caves, and deserts.



The Color, Shape, and Size of Spiders vary greatly. Some crab spiders slowly change color from white to yellow to match the flowers in which they hide. The spiny-bodied spider, hanging from its dragline, looks like a chip of wood. Some kinds of comb-footed spiders are less than 1/50 inch (0.5 millimeter) long, and are among the world's smallest spiders. South American tarantulas are the largest spiders. One tarantula was 10 inches (25 centimeters) long with its legs extended.

Spiders shown other than natural size are accompanied by a drawing showing natural size. All spiders shown are females except where noted.

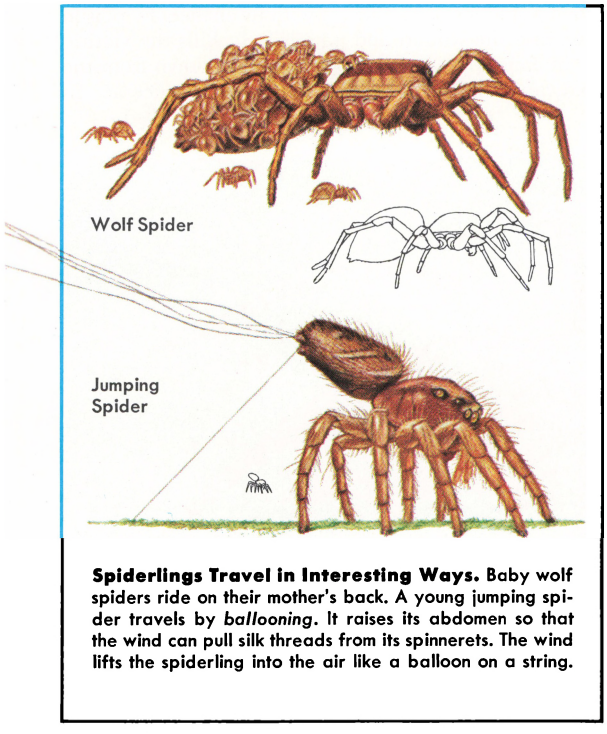
One kind of spider spends most of its life under water. Another kind lives near the top of Mount Everest, the world's highest mountain. Some spiders live in houses, barns, or other buildings. Others live on the outside of buildings—on walls, on window screens, or in the corners of doors and windows.

There are more than 29,000 known kinds of spiders, but scientists believe there may be as many as 50,000 kinds. Some kinds are smaller than the head of a pin. Others are as large as a man's hand. One spider, a South American tarantula, measured 10 inches (25 centimeters) long with its legs extended.

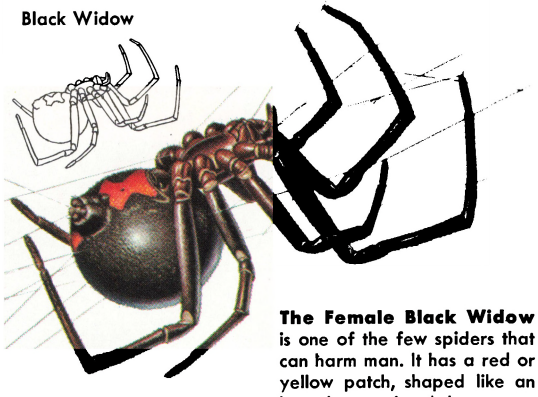
Many persons think spiders are insects. But scientists classify spiders as *arachnids*, which differ from insects in many ways. Spiders have eight legs. Ants, bees, beetles, and other insects have six legs. Most insects have wings and *antennae* (feelers), but spiders do not. Other arachnids include daddy longlegs, scorpions, and mites and ticks.

Scientists classify spiders as either *true spiders* or *tarantulas* according to certain differences in their bodies. Spiders can also be divided according to their way of life. *Web-spinning spiders* spin webs to trap insects. *Hunting spiders* run after insects or lie in wait for them. For the scientific classification of spiders, see the table *Common Kinds of Spiders* at the end of this article.

H. K. Wallace, the contributor of this article, is Chairman of the Department of Zoology at the University of Florida. Willis J. Gertsch, the critical reviewer, is Curator of Arachnids at the American Museum of Natural History, and author of American Spiders. *The illustrations throughout this article were prepared for* World Book *by Jack J. Kunz unless otherwise credited.*

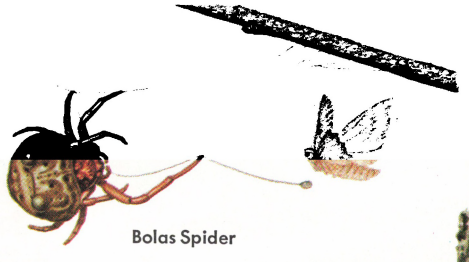


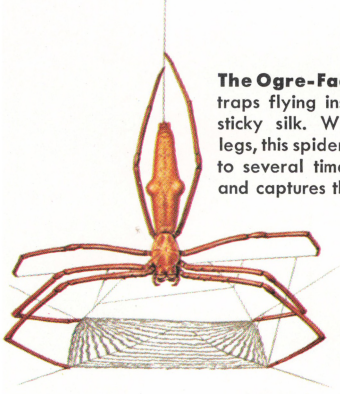
Spiderlings Travel in Interesting Ways. Baby wolf spiders ride on their mother's back. A young jumping spider travels by *ballooning*. It raises its abdomen so that the wind can pull silk threads from its spinnerets. The wind lifts the spiderling into the air like a balloon on a string.



The Female Black Widow is one of the few spiders that can harm man. It has a red or yellow patch, shaped like an hourglass, on its abdomen.

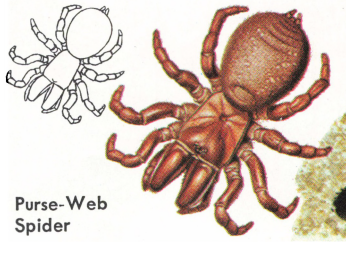
The Bolas Spider does not trap insects in a web. Instead, it spins a line of silk with a drop of sticky silk at the end. The spider swings the line at an insect and traps it in the sticky ball.

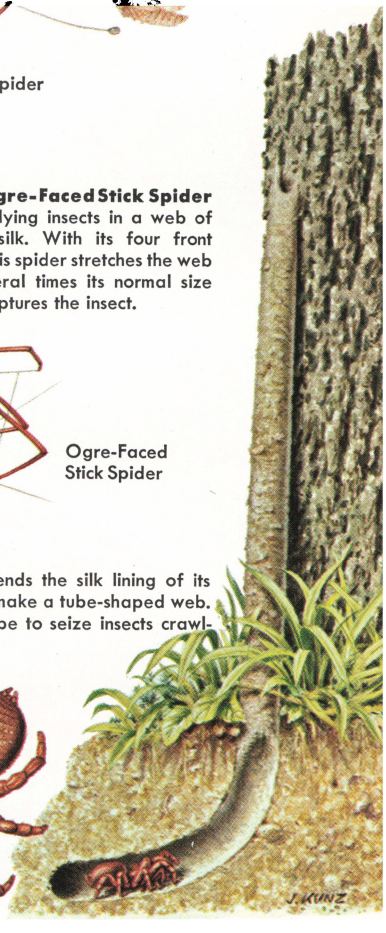




The Ogre-Faced Stick Spider traps flying insects in a web of sticky silk. With its four front legs, this spider stretches the web to several times its normal size and captures the insect.

The Purse-Web Spider extends the silk lining of its burrow up the side of a tree to make a tube-shaped web. The spider bites through the tube to seize insects crawling over its web.





Spiders may be short and fat, long and thin, round, oblong, or flat. Their legs are short and stubby, or long and thin. Most spiders are brown, gray, or black. But some are as beautifully colored as the loveliest butterflies. Many of these spiders are so small that their colors can be seen only with a microscope.

A spider has no bones. Its tough skin serves as a protective outer skeleton. Hairs, humps, and *spines* (bristles of skin) cover the bodies of most spiders.

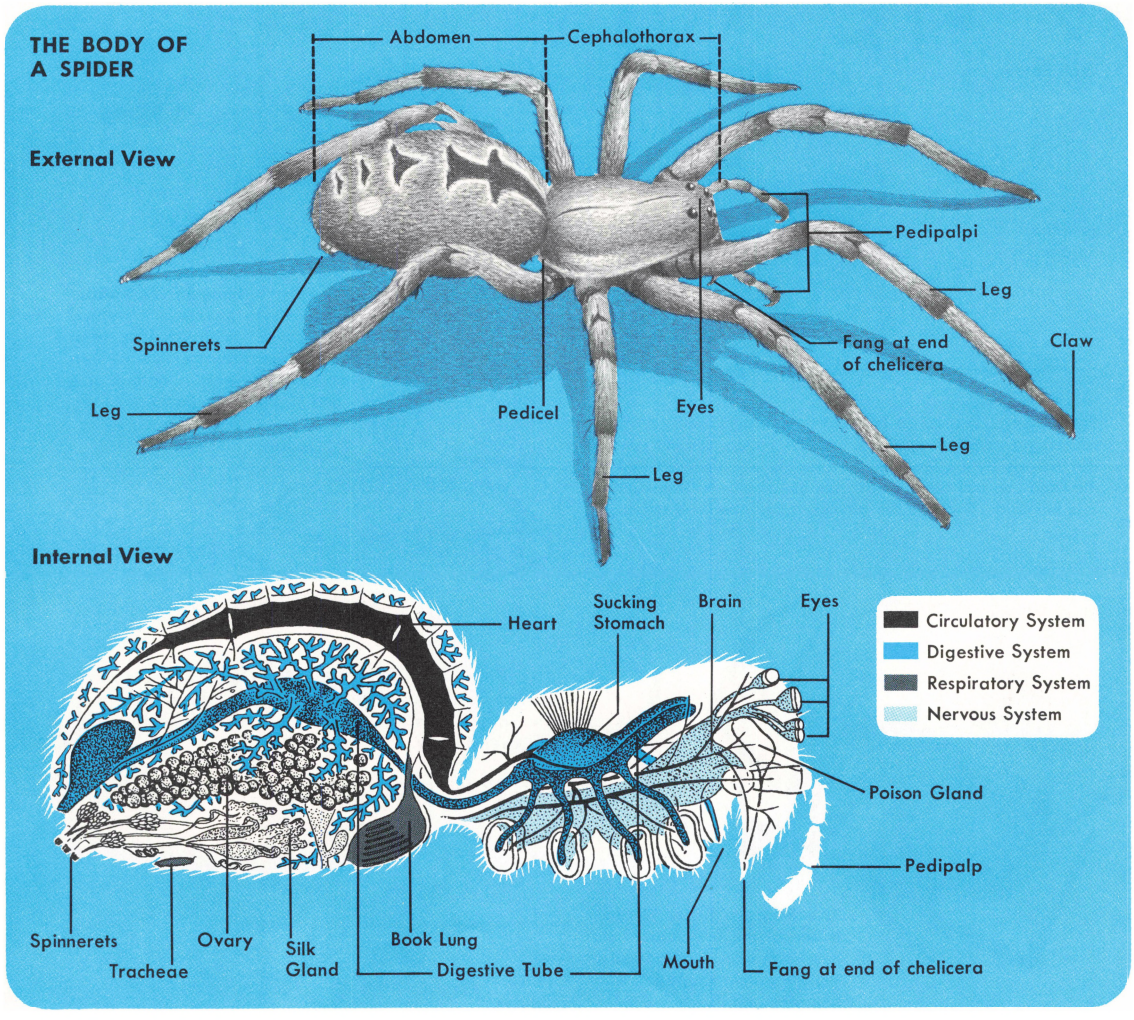
A spider's body has two main sections: (1) the *cephalothorax*, which consists of the head joined to the *thorax* (chest); and (2) the *abdomen*. Each of these sections has *appendages* (attached parts). A thin waist called the *pedicel* connects the cephalothorax and the abdomen.

Eyes. A spider's eyes are on top and near the front of its head. The size, number, and position of the eyes vary among different species. Most species have eight eyes, arranged in two rows of four each. Other kinds have six, four, or two eyes. Some species of spiders that live in caves or other dark places have no eyes at all.

Mouth. A spider's mouth opening is below its eyes. Spiders do not have chewing mouth parts, and they eat only liquids. Various appendages around the mouth opening form a short "straw" through which the spider sucks the body fluid of its victim. The spider can eat some of the solid tissue of its prey by *predigesting* it. To do this, the spider sprays digestive juices on the tissue. The powerful juices dissolve the tissue. By predigestion and sucking, a large tarantula can reduce a mouse to a small pile of hair and bones in about 36 hours.

Chelicerae are a pair of appendages that the spider uses to seize and kill its prey. The chelicerae are above the mouth opening and just below the spider's eyes. Each chelicera ends in a hard, hollow, pointed claw, and these claws are the spider's fangs. An opening in the tip of the fang connects with the poison glands. When a spider stabs an insect with its chelicerae, poison flows into the wound and paralyzes or kills the victim.

The fangs of tarantulas point straight down from the head, and the poison glands are in the chelicerae. In



true spiders, the fangs point crosswise, and the poison glands extend back into the cephalothorax.

Spiders also crush their prey with their chelicerae. Some species use their chelicerae to dig burrows in the ground as nests.

Pedipalpi are a pair of appendages that look like small legs. One pedipalp is attached to each side of the spider's mouth, and they form the sides of the mouth opening. Each pedipalp has six *segments* (parts). In most kinds of spiders, the segment closest to the body bears a sharp plate with jagged edges. The spider uses this plate to cut and crush its food. In male spiders, the last segment of each pedipalp bears a reproductive organ.

Legs. A spider has four pairs of legs, which are attached to its cephalothorax. Each leg has seven segments. In most kinds of spiders, the last segment has two or three claws at the tip. A pad of hairs called a *scopula* may surround the claws. The scopula helps the spider cling to such surfaces as ceilings or walls.

When a spider walks, the first and third leg on one side of its body move with the second and fourth leg on the other side. Muscles in the legs make the legs bend at the joints. But spiders have no muscles to extend their legs. The pressure of the blood in their bodies makes their legs extend. If a spider's body does not contain enough fluids, its blood pressure drops. The legs draw up under the body, and the animal cannot walk.

Spinnerets are short, fingerlike organs with which the spider spins silk. They are attached to the rear of the abdomen. Most kinds of spiders have six spinnerets, but some have four or two. The tip of a spinneret is called the *spinning field.* The surface of each spinning field is covered by as many as a hundred *spinning tubes.* Through these tubes, liquid silk flows from silk glands in the spider's abdomen to the outside of its body. The silk then hardens into a thread.

Respiratory System. Spiders as a group have two kinds of breathing organs—*tracheae* and *book lungs.* Tracheae, found in almost all kinds of true spiders, are small tubes which carry air throughout the body. Air enters the tubes through the *spiracle,* an opening in front of the spinnerets in most kinds of true spiders.

Book lungs are in cavities in the spider's abdomen. Air enters the cavities through a tiny slit on each side and near the front of the abdomen. Each lung consists of 15 or more thin, flat folds of tissue arranged like the pages of a book. The sheets of tissue contain many blood vessels. As air circulates between the sheets, oxygen passes into the blood. Tarantulas have two pairs of book lungs. Most true spiders have one pair.

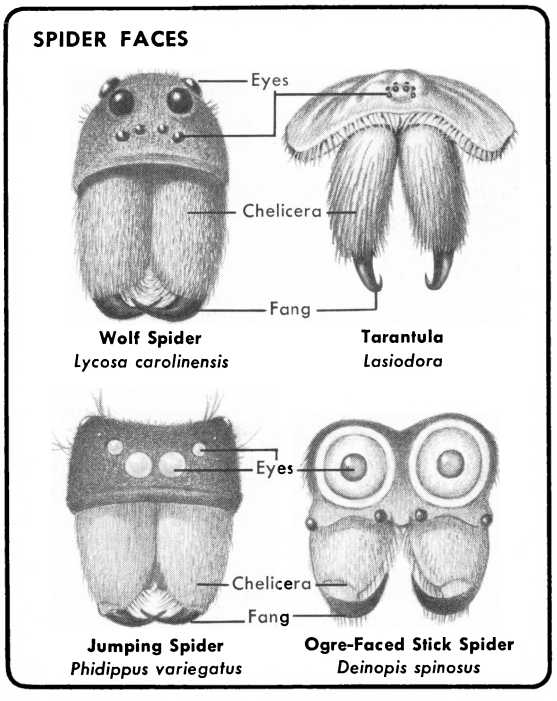
Circulatory System. The blood of spiders contains many pale blood cells and is transparent. The heart, a long, slender tube in the abdomen, pumps the blood to all parts of the body. As the blood circulates, it flows through open passages instead of closed tubes, such as those of the human body. If the spider's skin is broken, the blood quickly drains from its body. The animal's tough skin often prevents this from happening.

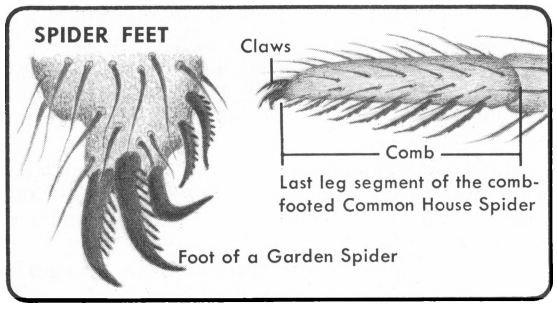
Digestive System. A digestive tube extends the length of the spider's body. In the cephalothorax, the tube is larger and forms a *sucking stomach.* When the stomach's powerful muscles contract, the size of the stomach increases. This causes a strong sucking action that pulls the food through the stomach into the intestine. Juices in the digestive tube break the liquid food into particles small enough to pass through the walls of the intestine into the blood. The food is then distributed to all parts of the body.

Nervous System. The central nervous system of a spider is in the cephalothorax. It includes the brain, and controls the activities of all other parts of the body.

A spider gains knowledge of its surroundings through its sense organs. Most kinds of hunting spiders can see better than web-spinning spiders. But all spiders can see only a short distance. The sense of touch is the most highly developed of the animal's senses. Special hairs on its body serve as organs of touch and perhaps as organs of hearing and smell. Each hair contains a nerve. These nerves send messages to the brain that tell the spider how to respond to changes in its surroundings. Spiders can easily sense vibrations and the presence of certain chemicals.

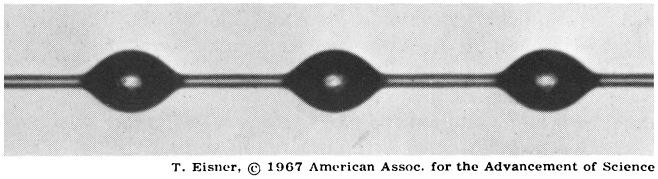
WORLD BOOK illustrations by Tom Dolan





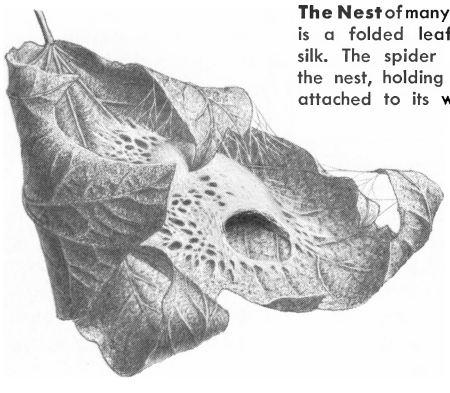
Jerome Wexler, NAS

Many Kinds of Spiders Spin Bands of Silk to tie up insects caught in webs. The orange garden spider turns its victim over and over, wrapping it in silk from the spider's spinnerets.



T. Eisner, © 1967 American Assoc. for the Advancement of Science

A Thread of Sticky Silk, enlarged more than 20 times, looks like a beaded necklace. Insects stick to the thread. Oil on the spider's body prevents the silk from sticking to the spider.



The Nest of many orb weavers is a folded leaf lined with silk. The spider hides inside the nest, holding a trap line attached to its web nearby.

How Spiders Make Silk. Spiders as a group have seven kinds of silk glands. No species of spider has all seven kinds. All spiders have at least three kinds of silk glands, and most species have five. Each kind of gland produces a different type of silk that the spider uses for a particular purpose.

Some silk glands produce a liquid silk that becomes dry outside the body. Other glands produce a sticky silk that stays sticky.

The spinnerets, which spin the silk, work somewhat like the fingers of a hand. A spider can stretch out each spinneret, pull it back in, and even squeeze them all together. Using different spinnerets, a spider can combine silk from different silk glands and produce a very thin thread or a thick, wide band.

The animal also can make a sticky thread that looks like a beaded necklace. To do this, the spider pulls out a dry thread that is heavily coated with sticky silk. Using the claws of one of its hind legs, the spider stretches this thread and lets go of it with a snap. This action causes the liquid silk to form a series of tiny beads along the thread. A spider uses beaded threads in its web to trap jumping or flying insects.

Some kinds of spiders have another spinning organ called the *cribellum*. It is an oval plate that lies almost flat against the abdomen, in front of the spinnerets. Hundreds of spinning tubes cover the spinning field of the cribellum. These tubes produce extremely thin threads of sticky silk.

Spiders with a cribellum also have a special row of curved hairs called a *calamistrum* on their hind legs. Spiders use the calamistrum to comb together dry silk from the spinnerets and sticky silk from the cribellum. This combination forms a flat, ribbonlike silk structure called a *hackled band*. Spiders use hackled bands in their webs, along with the other silk they spin.

How Spiders Use Silk. Spiders, including those that do not spin webs, depend on silk in so many ways that they could not live without it. Wherever a spider goes, it spins a silk thread behind itself. This thread is called a *dragline*. The dragline is sometimes called the spider's "lifeline" because the animal often uses it to escape from enemies. If danger threatens a spider in its web, it can drop from the web on its dragline and hide in the grass. Or the spider can simply hang in the air until the danger has passed. Then it climbs back up the dragline into its web. Hunting spiders use their draglines to swing down to the ground from high places.

Spiders also use silk to spin tiny masses of sticky threads called *attachment discs*. They use the discs to attach their draglines and webs to various surfaces.

Each kind of spider builds a different type of silk nest as its home. Some spiders line a folded leaf with silk to make a nest. Others dig burrows in the ground and line them with silk. Still others build nests in the center of their webs.

Many web-spinning spiders spin sticky bands or wide sheets of silk while capturing their prey. The orb weavers wrap their victims in sheets like mummies so they cannot escape.

The female spider of most species encloses her eggs in an *egg sac*, a bag made of a special kind of silk.

SPIDER / *Hunting Spiders*

Hunting spiders creep up on their prey or lie in wait and pounce on it. Most kinds of hunters have large eyes and can see their prey from a distance. The powerful chelicerae of hunting spiders help them overpower their victims. Some hunting spiders spin simple webs that stretch out along the ground and stop insects. These spiders are grouped as hunters because they run after the insects that land in their webs.

Jumping Spiders creep up and pounce on their prey. They have short legs, but they can jump more than 40 times the length of their bodies. Jumping spiders are the most colorful of all spiders. Many thick, colored hairs cover their bodies. Most of the males have bunches of brightly colored hairs on their first pair of legs.

Water Spiders are the only spiders that live most of their life underwater. This spider breathes underwater from air bubbles that it holds close to its body. Its underwater nest is a silk web shaped like a small bell. The spider fills the web with air bubbles, which gradually push all the water out of the bell. The animal can live on this air for several months. Water spiders are found only in Europe and parts of Asia. See ANIMAL (How Animals Breathe [picture]).

Tarantulas are the world's largest spiders. The biggest ones live in the South American jungles. Great numbers of tarantulas also are found in the southwestern United States.

Many kinds of tarantulas dig burrows as nests. The *trap-door spider* covers the entrance to its burrow with a lid (see TRAP-DOOR SPIDER). A California tarantula builds a *turret* (small tower) of grass and twigs at the entrance to its burrow. It sits on the tower and watches for insects moving in the nearby grass. See ANIMAL (Animals of the Tropical Forests [picture]); TARANTULA.

Fisher Spiders live near water and hunt water insects, small fish, and tadpoles. These spiders have large bodies and long, thin legs. But because of their light weight, they can walk on the water without sinking. They are sometimes called *nursery-web weavers* because the female builds a special web for her young.

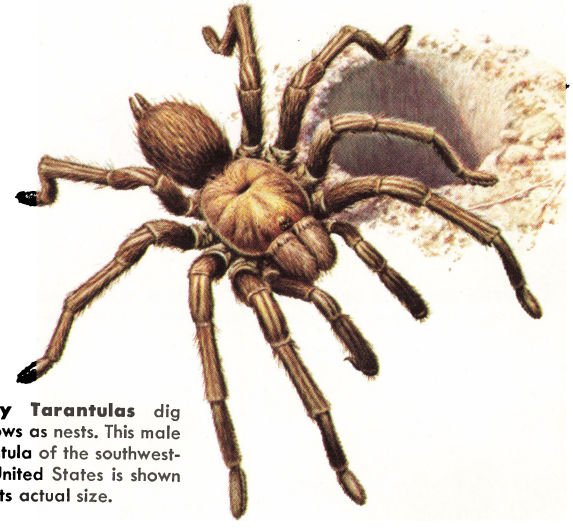
Crab Spiders have short, wide bodies and look like small crabs. They can walk backwards and sidewards as easily as crabs do. Some brightly colored crab spiders hide in flowers and capture bees and butterflies. A few kinds of crab spiders can disguise themselves by changing the color of their bodies to match the color of the flower blossom. *Huntsman spiders* are large, tan crab spiders of the southern United States.

Funnel-Web Spiders hunt only within large webs that they spin in tall grass or under rocks or logs. The bottom of the web is shaped like a funnel and serves as the spider's hiding place. The top part of the web forms a large sheet of silk spread out over grass or soil. When an insect lands on the sheet, the spider runs out of the funnel and pounces on the victim.

Wolf Spiders are excellent hunters. Many kinds have large, hairy bodies, and run swiftly in search of food. Others look and act like other types of spiders. For example, some live near water and resemble fisher spiders in appearance and habits. Others live in burrows, or spin funnel-webs. See ANIMAL (Animals of the Mountains [picture]).

A Jumping Spider leaps into space after its prey, and floats to the ground on a dragline.

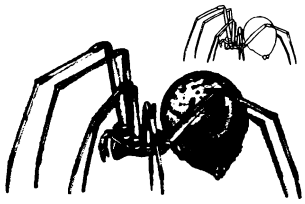
Water Spiders live underwater in airtight silk nests. There they eat, molt, mate, and raise families.



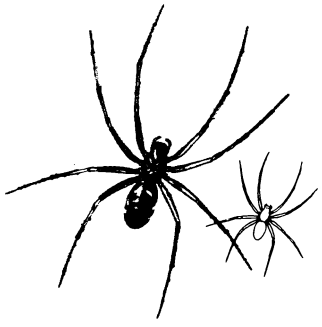
Many Tarantulas dig burrows as nests. This male tarantula of the southwestern United States is shown half its actual size.

A Female Fisher Spider stands guard over her egg sac after enclosing it in a special nursery web.

A Grass Spider spends its life spinning one funnel web. The female leaves the web only to build an egg sac.



The Common House Spider spins a loosely-woven tangled web of dry silk, held in place by long threads attached to walls or other supports. The center of the web forms a large insect trap.



The Platform Spider spins a silk sheet below a net of criss-crossed threads. Flying insects hit the net and fall onto the sheet.

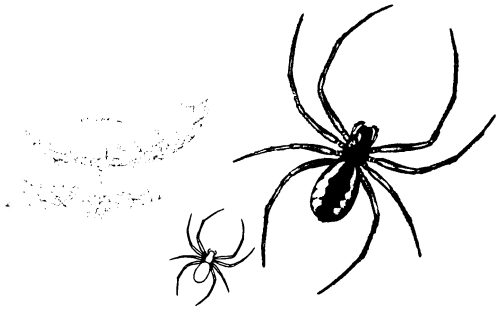
Web-spinning spiders, like hunting spiders, live in caves, in grass or shrubs, or in trees. They cannot catch food by hunting because of their poor vision. Instead, they spin webs in the air to trap flying insects. A web-spinning spider does not become caught in its own web. When walking across the web, it grasps the silk lines with a special hooked claw on each foot.

Tangled-Web Weavers spin the simplest type of web. It consists of a shapeless jumble of threads attached to a support, such as the corner of a ceiling. The *cobwebs* found in houses are tangled webs that have collected dust and dirt.

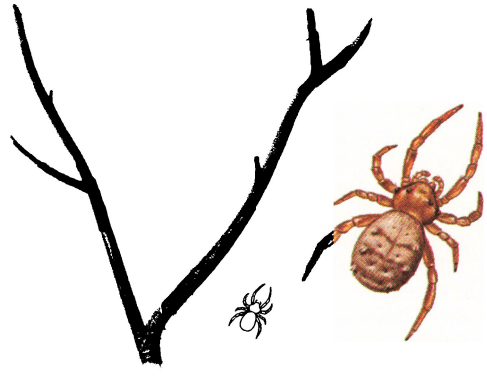
The *cellar spiders* spin tangled webs in dark, empty parts of buildings. One cellar spider that looks like a daddy longlegs has thin legs more than 2 inches (5 centimeters) long.

The *comb-footed spiders* spin a tangled web with a tightly woven sheet of silk in the middle. The sheet serves as an insect trap and as the spider's hideout. These spiders get their name from the comb of hairs on their fourth pair of legs. They use the comb to throw liquid silk over an insect and trap it. The *black widow* is a comb-footed spider (see BLACK WIDOW).

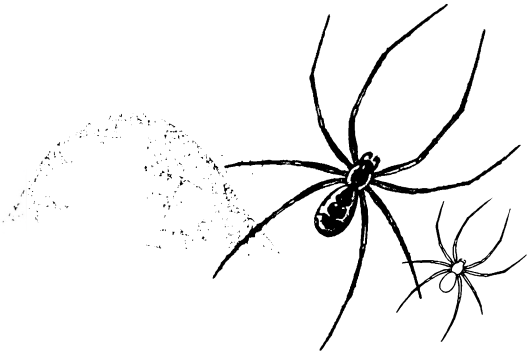
Some spiders spin a tangled web containing a hackled band of dry and sticky silk. The *ogre-faced stick spider*



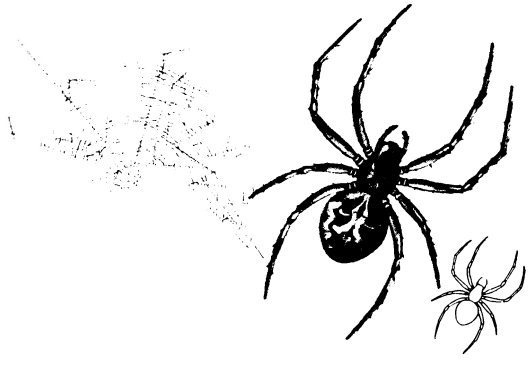
The Bowl-and-Doily Spider spins a bowl-shaped sheet above a flat sheet of silk. Threads above the bowl stop flying insects.



The Triangle Spider spins a triangular web between two twigs. The web's *hackled bands* of dry and sticky silk trap insects.



The Filmy Dome Spider spins a tangle of threads around a dome-shaped silk sheet, and hangs under the dome. Insects that drop onto the dome are pulled through the webbing by the spider.



The Labyrinth Spider spins a tangled web as its hiding place and an orb web as an insect trap. Several trap lines extend from the center of the orb web to the tangled web.

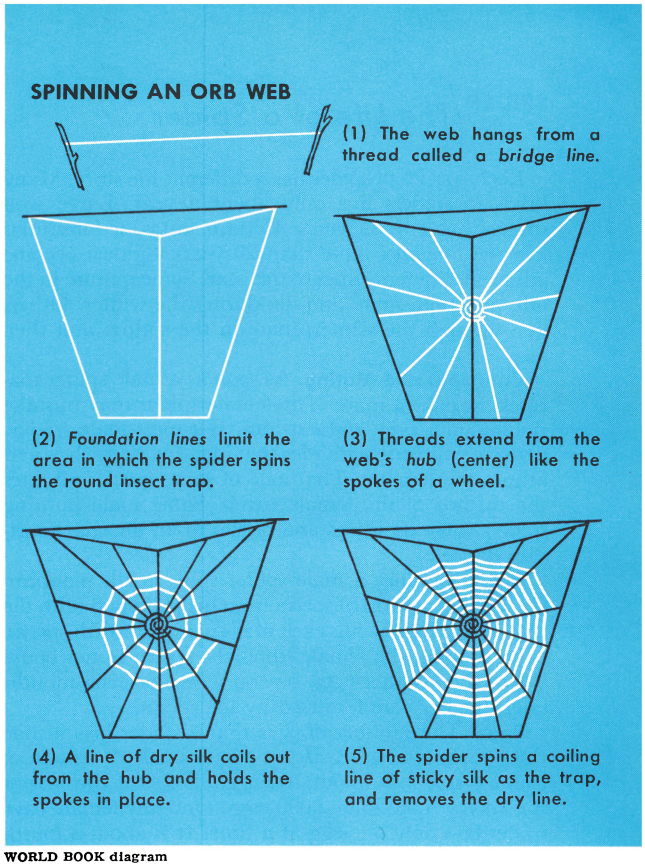
spins a web that is made up largely of hackled bands. The web is only about as large as a postage stamp. This spider spins a structure of dry silk to hold the sticky web in place. With its four rear legs, the spider hangs upside down from the dry silk. It holds the sticky web with its four front legs. When an insect flies near, the spider stretches the sticky web to several times its normal size and captures the insect.

Sheet-Web Weavers weave flat sheets of silk between blades of grass or branches of shrubs or trees. These spiders also spin a net of crisscrossed threads above the sheet web. When a flying insect hits the net, it bounces into the sheet web. The spider, which hangs upside down beneath the web, quickly runs to the insect and pulls it through the webbing. Sheet webs last a long time because the spider repairs any damaged parts. *Dwarf spiders*, which are less than $\frac{1}{20}$ inch (1.3 millimeters) long, spin small, square sheet webs near rivers and lakes.

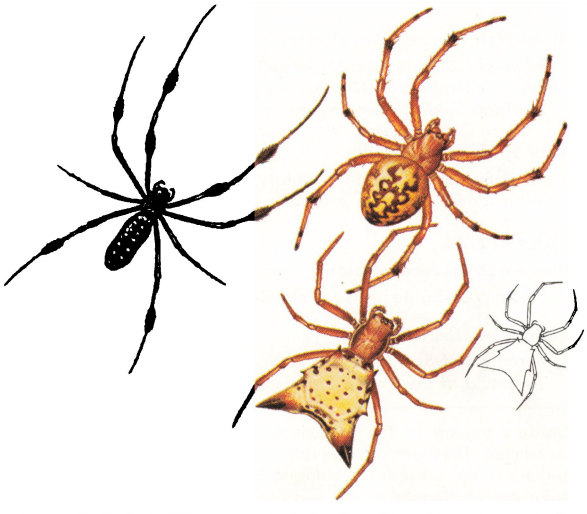
Some sheet-web weavers spin two separate sheets as a web. The spider hangs upside down under the top sheet. The sheet beneath the spider probably protects it from attack from below.

Orb Weavers build the most beautiful and complicated of all webs. They weave their round webs in open areas, often between tree branches or flower stems. Threads of dry silk extend from an orb web's center like the spokes of a wheel. Coiling lines of sticky silk connect the spokes, and serve as an insect trap.

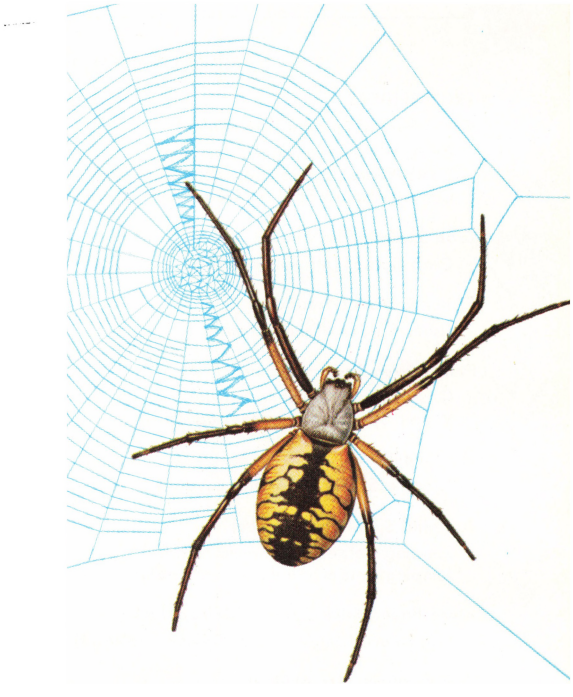
Some orb weavers lie in wait for their prey in the center of the web. Others attach a *trap line* to the center of the web. The spider hides in its nest near the web, and holds on to the trap line. When an insect lands in the web, the line vibrates. The spider darts out and captures the insect. Many orb weavers spin a new web every night. It takes them about an hour. Other orb weavers repair or replace damaged parts of their webs.



WORLD BOOK diagram



Beautiful Orb Weavers include the silk spider, shown half its actual size at the left; the marbled spider, *above right*; and the arrowhead-shaped micrathena, *below right*.



The Orange Garden Spider spins a large orb web that may measure more than 2 feet (61 centimeters) across. The spider spins a zigzagging band of silk across the middle of the web.

SPIDER / *The Life of a Spider*

Each species of spider has a different life story. Many kinds of spiders live only about a year. Large wolf spiders live several years. Certain kinds of tarantulas live the longest—more than 20 years. Spiders become adults at different times of the year. Some mature in the fall, and then mate and die during the winter. Others live through the winter, mate in the spring, and then die.

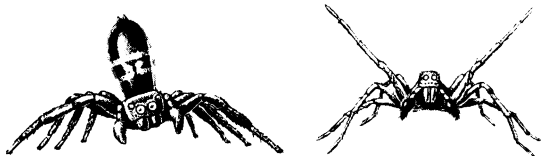
Courtship and Mating. As soon as a male spider matures, it seeks a mate. The female spider may mistake the male for prey and eat him. But most male spiders perform courtship activities that identify themselves and attract the females. The male of some species vibrates the threads of the female's web. Some male hunting spiders wave their legs and bodies in an unusual courtship dance.

Before mating, a male spider spins a silk platform. He deposits a drop of sperm from his abdomen onto the platform. Then he fills each of his pedipalpi with sperm. After mating, the female stores the sperm in her body. When she lays her eggs, several weeks or even months later, the eggs are fertilized by the sperm.

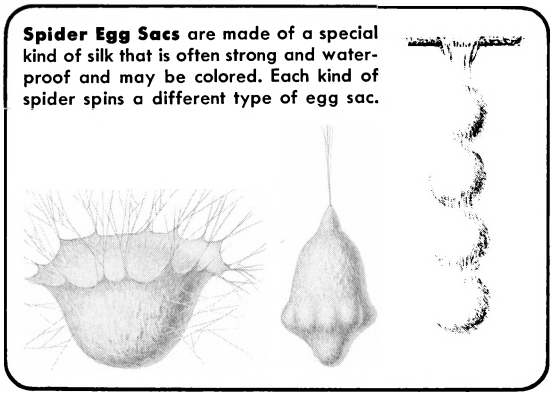
Eggs. The number of eggs that a spider lays at one time varies with the size of the animal. A female of average size lays about 100 eggs. Some of the largest spiders lay more than 2,000 eggs. One tiny female cave spider lays only one egg at a time. It is about a fourth the size of her body.

In most species, the mother spider encloses the eggs in a silken egg sac. The sac of each species differs in size and shape. Some species that lay large numbers of eggs make several sacs, and some spin them together into a long chain.

In many species, the mother dies soon after making the egg sac. In other species, she stays with the eggs



Courtship Dances are performed by many male hunting spiders to attract mates. The jumping spider *Peckhamia noxiosa, left,* raises its abdomen into the air and sways from side to side. The wolf spider *Pardosa milvina, right,* waves its front pair of legs.



Spider Egg Sacs are made of a special kind of silk that is often strong and waterproof and may be colored. Each kind of spider spins a different type of egg sac.

COMMON KINDS OF SPIDERS

Each of the spiders listed in this table is shown in the pictures with this article.

TRUE SPIDERS

Comb-Footed Spiders (*Theridiidae*)
- Black Widow (*Latrodectus mactans*)
- Comb-Footed Spider (*Mysmena incredula*)
- Common House Spider (*Achaearanea tepidariorum*)

Crab Spiders (*Thomisidae*)
- Crab Spider (*Misumena vatia*)

Fisher Spiders (*Pisauridae*)
- Fisher Spider (*Pisaurina mira*)

Funnel-Web Spiders (*Agelenidae*)
- Grass Spider (*Agelena naevia*)
- Water Spider (*Argyroneta aquatica*)

Hackled-Band Orb Weavers (*Uloboridae*)
- Triangle Spider (*Hyptiotes cavatus*)

Jumping Spiders (*Salticidae*)
- Jumping Spider (*Peckhamia noxiosa*)
- Jumping Spider (*Phidippus variegatus*)

Ogre-Faced Stick Spiders (*Deinopidae*)
- Ogre-Faced Stick Spider (*Deinopis spinosus*)

Orb Weavers (*Argiopidae*)
- Arrowhead-Shaped Micrathena (*Micrathena sagittata*)
- Bolas Spider (*Mastophora cornigera*)
- Labyrinth Spider (*Metepeira labyrinthea*)
- Marbled Spider (*Araneus marmoreus*)
- Orange Garden Spider (*Argiope aurantia*)
- Silk Spider (*Nephila clavipes*)
- Spiny-Bodied Spider (*Gasteracantha cancriformis*)

Sheet-Web Weavers (*Linyphiidae*)
- Bowl-and-Doily Spider (*Frontinella pyramitela*)
- Filmy Dome Spider (*Linyphia marginata*)
- Platform Spider (*Microlinyphia mandibulata*)

Wolf Spiders (*Lycosidae*)
- Wolf Spider (*Lycosa punctulata*)
- Wolf Spider (*Pardosa milvina*)

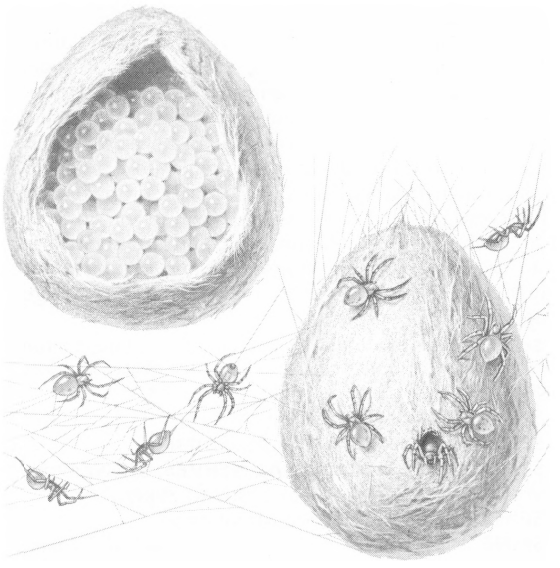
TARANTULAS

Purse-Web Spiders (*Atypidae*)
- Purse-Web Spider (*Atypus abboti*)

Tarantulas (*Theraphosidae*)
- Tarantula of South America (*Lasiodora*)
- Tarantula of the United States (*Aphonopelma chalcodes*)

Spiders belong to the phylum *Arthropoda,* and to the class *Arachnida.* They make up the spider order *Araneae.* True spiders belong to the suborder *Labidognatha.* Tarantulas belong to the suborder *Orthognatha.*

To learn how spiders fit into the animal kingdom, see ANIMAL (table: A Classification of the Animal Kingdom).



Spiderlings hatch from pearly white eggs inside the egg sac. One by one, they leave the egg sac through a tiny hole that they tear in its side. They immediately begin spinning draglines. Many spiderlings then travel to other areas, usually by ballooning.

until they hatch. Some spiders hang the sac in a web. Others attach the sac to leaves or plants. Still others carry it with them. The female wolf spider attaches the sac to her spinnerets, and drags it behind her.

Spiderlings hatch inside the egg sac and remain there until warm weather arrives. If the eggs are laid in autumn, the spiderlings stay quietly inside their egg sac until spring. After leaving the egg sac, the spiderlings immediately begin spinning draglines.

Many spiderlings travel to other areas. To do this, a spiderling climbs to the top of a fence post or some other tall object and tilts its spinnerets up into the air. The moving air pulls silk threads out of the spinnerets. Then the wind catches the threads and carries the spiderling into the air like a balloon on a string. This unusual way of traveling is called *ballooning*. A spider may travel a great distance by ballooning. Sailors more than 200 miles (320 kilometers) from land have seen ballooning spiders floating through the air.

Spiderlings *molt* (shed their outer skin) several times while they are growing. A new, larger skin replaces the skin that has grown too tight. Most kinds of spiders molt from five to nine times before they reach adulthood. Tarantulas molt more than 20 times, but dwarf spiders molt only a few times.

Enemies of spiders include snakes, frogs, toads, lizards, birds, fish, and many other animals that also eat insects. Even some insects eat spiders. The wasp, for example, is one of the spider's worst enemies (see WASP [Solitary Wasps]). One group of spiders called *pirate spiders* eats only other spiders. Pirate spiders do not spin webs, but creep into the webs of other spiders and kill them.

H. K. WALLACE

Critically reviewed by WILLIS J. GERTSCH

SPIDER / *Study Aids*

Related Articles in WORLD BOOK include:

Arachne	Black Widow	Tarantula
Arachnid	Brown Recluse	Trap-Door Spider
Arthropod	Bruce, Robert	

Outline

I. The Spider's Body
- A. Eyes
- B. Mouth
- C. Chelicerae
- D. Pedipalpi
- E. Legs
- F. Spinnerets
- G. Respiratory System
- H. Circulatory System
- I. Digestive System
- J. Nervous System

II. The Spider's Silk
- A. How Spiders Make Silk
- B. How Spiders Use Silk

III. Hunting Spiders
- A. Jumping Spiders
- B. Water Spiders
- C. Tarantulas
- D. Fisher Spiders
- E. Crab Spiders
- F. Funnel-Web Spiders
- G. Wolf Spiders

IV. Web-Spinning Spiders
- A. Tangled-Web Weavers
- B. Sheet-Web Weavers
- C. Orb Weavers

V. The Life of a Spider
- A. Courtship and Mating
- B. Eggs
- C. Spiderlings
- D. Enemies

Questions

What is ballooning?
What are some of the ways in which spiders use silk?
How do tarantulas differ from true spiders?
How does an orb weaver know that an insect has landed in its web?
How do spiders differ from insects?
How many kinds of spiders in the United States can harm man?
How does a female wolf spider carry her egg sac?
What is the only food of pirate spiders?
Why are spiders valuable to man?
Why is a dragline often called a spider's "lifeline"?

SPIDER MONKEY is a large monkey noted for using its tail as an extra limb. It can hang by its tail and even pick up objects by curling it around them. This monkey sometimes hangs upside down, with all four long, thin limbs and slender tail grasping a branch. It resembles a huge spider in this position. These spry monkeys often use their arms to swing from branch to branch. Only small Asian apes called gibbons can swing through the trees faster.

Spider monkeys live in groups in the tropical forests of the Western Hemisphere, from central Mexico to central Bolivia. They stay in high branches, where they eat fruits and nuts. Various species have black, brown, golden, reddish, or tan fur. Adult spider monkeys weigh from 10 to 15 pounds (5 to 7 kilograms) and grow almost 2 feet (61 centimeters) long, not including the tail. Spider monkeys, unlike almost all other monkeys, have only four fingers and no thumb.

Scientific Classification. Spider monkeys belong to the New World monkey family, *Cebidae*. They make up the genus *Ateles*. A common species of spider monkey is *A. paniscus*.

NEIL C. TAPPEN

See also ANIMAL (Animals of the Tropical Forests [picture]); MONKEY (picture).

SPIDERWORT, *SPI der WURT*, is the common name for a group of mostly tropical plants. Some of them are

ornamental plants. The leaves of the spiderworts are often grasslike and sometimes striped. The flowers may be blue, purple, or white. They are fragile and may dissolve into watery jelly. They have weak stems.

Some kinds of spiderworts grow erect, and some run along the ground. The *common spiderwort* is the best-known of the erect plants. An example of creeping spiderwort is the *wandering Jew* (see WANDERING JEW). It often grows under benches in greenhouses.

The spiderworts are perennials. Gardeners usually propagate them by taking cuttings from an old plant.

Scientific Classification. Spiderworts belong to the spiderwort family, *Commelinaceae*. The common spiderwort is genus *Tradescantia*, species *T. virginiana*. The wandering Jew is *Zebrina pendula*. PAUL C. STANDLEY

SPIEGELEISEN, *SPEE gul i zun*, is a whitish pig iron that contains manganese and carbon. Steelworkers add it to melted steel to increase strength and remove oxygen. It raises the manganese content of steel when added to scrap steel and pig iron. See also IRON AND STEEL (The Open-Hearth Furnace); MANGANESE; MUSHET, ROBERT FORESTER.

SPIKE. See INFLORESCENCE.

SPIKENARD, *SPIKE nerd*, or NARD, is a plant related to the valerians. It comes from India and yields a costly perfume. The root is shaped like an ear of corn. A cluster of thick stems about 2 inches (5 centimeters) long grows from the top of the root. This part is the main source of the perfume. The Bible mentions the precious ointment of spikenard. The *American spikenard*, or *Indian root*, is an aromatic herb that grows in southern Canada and the northern United States.

Scientific Classification. The oriental, or "true," spikenard belongs to the valerian family, *Valerianaceae*. It is genus *Nardostachys*, species *N. jatamansi*. The American spikenard belongs to the ginseng family, *Araliaceae*. It is *Aralia racemosa*. HAROLD NORMAN MOLDENKE

SPILLWAY. See DAM (How Men Build Dams).

SPINACH, *SPIN ich*, is a popular garden vegetable. It is a low-growing annual plant that produces a thick cluster of wide, succulent leaves. People eat the leaves raw or cooked. Spinach is related to beets, Swiss chard, and the common weed lamb's-quarters.

Spinach comes from southwest Asia. The Persians once used it as medicine. Englishmen cultivated it as early as 1500, and Americans grew it during the colonial period. Spinach once was a special dish in Europe.

Spinach grows rapidly and matures in the cool season. It is easy to grow. The plant grows best in a fertile, sandy loam. It does not grow well in an acid soil. It withstands frost, but not heat. Gardeners sow the seeds in the spring. In about three months, the crop is ready for harvest. Another crop can be grown in the fall.

Spinach is high in vitamin value and in minerals. It is an excellent source of vitamins A and C, and a fair source of vitamins of the B complex. It also has a large amount of fiber, and acts as a mild laxative.

William M. Harlow

Spinach Leaves Are Rich in Minerals and Vitamins.

Scientific Classification. Spinach plants belong to the goosefoot family, *Chenopodiaceae*. They are genus *Spinacea*, species *S. oleracea*. ERVIN L. DENISEN

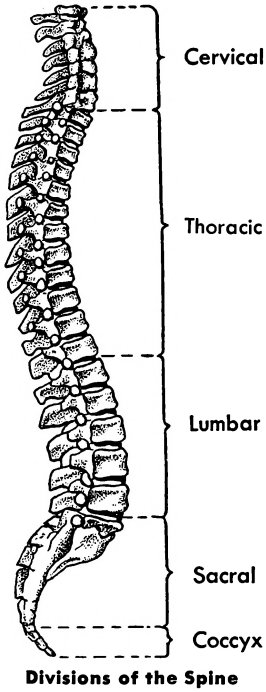
See also LAMB'S-QUARTERS.

SPINAL ANESTHESIA. See ANESTHESIA.

SPINAL CORD AND SPINAL NERVES. See NERVOUS SYSTEM (Parts of the Nervous System); SPINE.

SPINAL MENINGITIS. See MENINGITIS.

SPINE is the popular name for the *spinal column*, or *vertebral column*. The spine helps support the body of vertebrate animals. It is made up of a column of bones called *vertebrae*. The vertebrae are held in place by strong connective tissue called *ligaments*. There are 33 vertebrae, but some of them grow together in adults. There are 7 *cervical* (neck), 12 *thoracic* (chest region), 5 *lumbar* (lower back), 5 fused *sacral* (hip region), and 4 fused *coccygeal* (tailbone region or coccyx) vertebrae. The first cervical vertebra, the *atlas*, supports the skull. The sacral vertebrae unite with the pelvis (see PELVIS).



Divisions of the Spine

Each vertebra has two bony arches that form an opening called the *vertebral foramen*. The openings lie directly over one another, forming a continuous canal called the *vertebral canal*. The spinal cord extends from the lower part of the brain and passes through the canal. A pair of nerves branching off between each vertebra provide communication between the brain and all parts of the body.

The design of the spine provides strength and freedom of motion, yet the delicate spinal cord is protected. Sometimes vertebrae that are fractured in an accident may injure the spinal cord and cause *paralysis* (loss of muscle movement). GORDON FARRELL

Related Articles. See the Trans-Vision three-dimensional color picture with HUMAN BODY. See also:

Cerebrospinal Fluid
Hunchback
Meningitis
Myelitis
Nervous System
Scoliosis
Skeleton
Vertebra

SPINET, *SPIN eht,* was an early keyboard musical instrument. It is now a term used for upright pianos. The early spinet looked like a miniature grand piano. Its wire strings were plucked by quill, ivory, or wooden pieces called *plectra* attached to the keys. The spinet made a sound much like that of a music box. It was probably named after Giovanni Spinetti of Venice, Italy, who made important changes in its design in the 1500's. The *virginal* and *harpsichord* are modified forms of the spinet. See also PIANO. CHARLES B. RIGHTER

SPINGARN, JOEL ELIAS (1875-1939), was an American publisher and literary critic who introduced the works of European writers to American audiences.

Spingarn was born in New York City and studied at Columbia College (now Columbia University). After his graduation, he taught English literature at Columbia. During World War I, he served in France, and returned to join the staff of a publishing firm. His works include *A History of Literary Criticism in the Renaissance* and *Poetry: A Religion.*

After 1913, Spingarn was a leader in the National Association for the Advancement of Colored People. He established the Spingarn medal. HENRY LEE MOON

SPINGARN MEDAL awards were instituted by Joel Elias Spingarn, chairman of the board of the National Association for the Advancement of Colored People, in 1914. The awards are gold medals given each year to the Negro who, according to a committee appointed by the board, has reached the highest achievement in his field in that year, or over a period of time. See also NATIONAL ASSOCIATION FOR THE ADVANCEMENT OF COLORED PEOPLE; SPINGARN, JOEL E. HENRY LEE MOON

NAACP

The Spingarn Medal has a figure of justice on its face, *left.* The winner's name is engraved on the back, *right.*

SPINNERET. See SPIDER (The Spider's Body); RAYON.

SPINNING. See FISHING.

WINNERS OF SPINGARN MEDAL

Year	Medal Winners	Field of Achievement
1915	Ernest E. Just	Research in biology
1916	Charles Young	Organization of the Liberian constabulary
1917	*Harry T. Burleigh	Creative music
1918	W. S. Braithwaite	Literature
1919	Archibald H. Grimke	Politics and literature
1920	*William E. B. Du Bois	Founding of Pan-African Congress
1921	Charles S. Gilpin	Drama
1922	Mary B. Talbert	Helped create Frederick Douglass Shrine
1923	*George W. Carver	Agricultural chemistry
1924	*Roland Hayes	Concert singing
1925	*James Weldon Johnson	Literature
1926	*Carter G. Woodson	History
1927	Anthony Overton	Life insurance
1928	Charles W. Chesnutt	Literature
1929	Mordecai W. Johnson	Education, Howard U.
1930	Henry A. Hunt	Education in the South
1931	Richard B. Harrison	Drama
1932	*Robert R. Moton	Educational work
1933	Max Yergan	Interracial work in South Africa
1934	William T. B. Williams	Education, Tuskegee Institute
1935	*Mary McLeod Bethune	Education
1936	John Hope†	Education, Atlanta U.
1937	*Walter F. White	Civil rights
1938	No award given.	
1939	*Marian Anderson	Concert singing
1940	Louis T. Wright	Surgery and civic affairs
1941	*Richard Wright	Literature
1942	*A. Philip Randolph	Labor and civic affairs
1943	*William H. Hastie	Equal justice for Negroes
1944	*Charles R. Drew	Medicine
1945	*Paul Robeson	Singing and acting
1946	*Thurgood Marshall	Equality before the law
1947	*Percy L. Julian	Commercial chemistry
1948	Channing H. Tobias	Civil liberties
1949	*Ralph J. Bunche	UN mediator, Palestine
1950	Charles H. Houston†	Law; education
1951	Mabel K. Staupers	Equal rights for Negro nurses
1952	Harry T. Moore†	Civil liberties
1953	Paul R. Williams	Architecture
1954	*Theodore K. Lawless	Dermatology
1955	Carl Murphy	Publishing
1956	*Jackie Robinson	First Negro in modern major league baseball
1957	*Martin Luther King, Jr.	Civil rights
1958	Mrs. Daisy Bates Minnijean Brown Elizabeth Eckford Ernest Green Thelma Mothershed Melba Patillo Gloria Ray Terrence Roberts Jefferson Thomas Carlotta Walls	Arkansas NAACP First Negro students to attend Little Rock (Ark.) Central High School
1959	*Duke Ellington	Creative music
1960	*Langston Hughes	Literature
1961	*Kenneth B. Clark	Psychology; school integration
1962	*Robert C. Weaver	Government
1963	*Medgar W. Evers†	Equal rights for Negroes in Mississippi
1964	*Roy Wilkins	Civil rights
1965	*Leontyne Price	Opera singing
1966	*John H. Johnson	Publishing
1967	*Edward W. Brooke	Government
1968	Sammy Davis, Jr.	Entertainment
1969	Clarence M. Mitchell, Jr.	Fair housing legislation
1970	Jacob Lawrence	Paintings of Negro life
1971	*Leon H. Sullivan	Equal economic opportunities for Negroes
1972	Gordon Parks	Photographer, writer, film maker, composer
1973	Wilson C. Riles	Educator
1974	Damon J. Keith	Law
1975	*Henry Aaron	Baseball

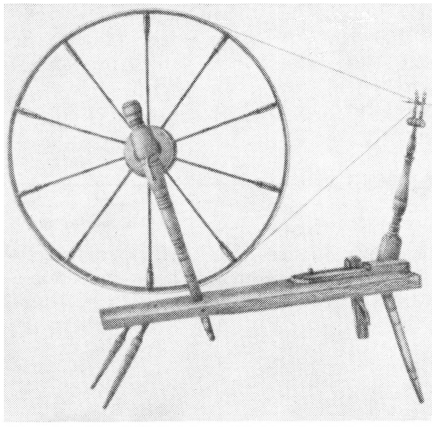
*Has a separate biography in WORLD BOOK
†Awarded posthumously

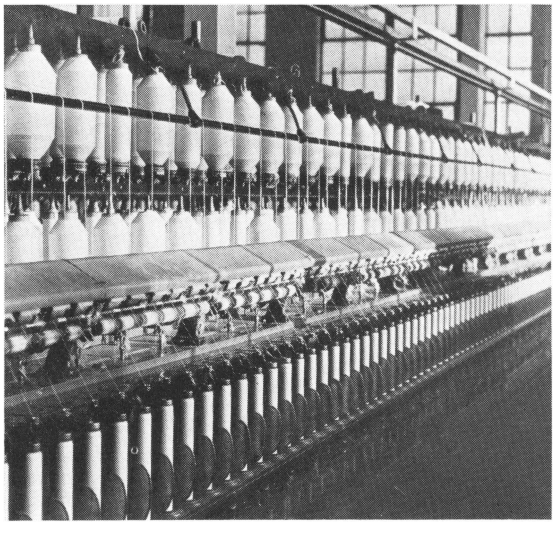
SPINNING

SPINNING is the process of making threads by twisting together plant or animal fibers. It is one of the most ancient arts. For thousands of years, yarn was spun by means of a *spindle*. This consisted of little more than a smooth stick from 9 to 15 inches (23 to 38 centimeters) long. It had a notch at one end for catching the thread, and a stone or baked clay bowl, called a *whorl*, to help make the spindle spin, like a top. The spinner turned the spindle by rolling it against the thigh. Ancient Egyptians used such spindles to make thread for fine cloth.

Ancient spinners in India and South America used finer spindles, usually in a bowl or on the ground. They spun cotton from combed rolls. Wool or flax fibers were wound around a stick called the *distaff*.

The Spinning Wheel, used in Europe as far back as the 1200's, was the first device to give the spindle a spinning movement. The principle was the same as the hand spindle, but the spindle was mounted horizontally. A band or small belt connected to a large wheel passed over a groove in the spindle and turned it. A foot pedal turned the wheel. A distaff carried the material to be spun. The material was drawn off the distaff by hand, and the fineness of the thread depended on the speed with which the twisting thread was drawn out. For very fine thread, two spinnings were necessary. New England housewives used this early type of spinning wheel in colonial times. It was as common then as the sewing machine is today.





National Gallery of Art, Index of American Design; National Cotton Council

The Old Spinning Wheel, *above,* so common to colonial houses, could make only one thread at a time. It could not compare with a modern spinning machine, *right,* which makes hundreds at a time, and gives threads firmness and strength.

The Spinning Jenny was invented by James Hargreaves in about 1764. This machine could spin more than one thread at a time. But it produced coarse thread rather than fine thread. No one really knows the origin of the term *jenny*. See SPINNING JENNY.

The Water Frame was a cotton-spinning machine patented by Richard Arkwright in 1769. Until then, all cloth had been woven with a linen *warp* (lengthwise threads) since no way had been found to spin cotton for the warp threads. Arkwright's frame drew cotton from the carding machine in a fine, hard-twisted thread suitable for the warp.

The Mule, introduced by Samuel Crompton in 1779, combined the principles of the spinning wheel and the water frame. It was also called the muslin wheel because it was widely used to produce this material. The mule had 48 spindles, and produced unusually fine and uniform yarn.

New spinning machines helped bring about that change in history known as the Industrial Revolution, when machines began to take the place of hand workers. The spinning machines created a demand for more cotton. This need brought about Eli Whitney's invention, the cotton gin. With more thread to weave, the weavers developed better and faster power looms. Then came machines to knit, to make lace, to embroider, to cut out patterns, and finally to sew cloth into finished ready-to-wear garments in large quantities.

Cotton spinning in a present-day factory is a typical example of most spinning. After the raw cotton has been cleaned and arranged into *laps* (bunches) of uniform size, it goes to the carding machines. These machines have huge rollers covered with wire teeth. Here the tangled fibers are straightened out and made to lie in straight, even rows. Then the fibers are rolled over and over one another to form *slivers*, which look like loose ropes of soft cotton yarn. A sliver goes through the processes of *drawing*, *slubbing*, and *roving*, by which it is twisted and retwisted and made continually finer and stronger. Spinning machines carry out these fine operations and give the thread the required twist, firmness, and strength.

New machines have been invented to spin the old natural fibers, such as flax and hemp, and new machines are being made for other fibers, such as kapok and ramie. Machines may someday be developed that will make cloth directly without first spinning thread, but until that time inventors will continue their efforts to improve spinning machines. ELIZABETH CHESLEY BAITY

Related Articles in WORLD BOOK include:

Arkwright, Sir Richard
Colonial Life in America (Clothing; pictures)
Cotton (Spinning; pictures)
Crompton, Samuel
Dyak (picture)
Hargreaves, James
Industrial Revolution (Spinning Machines)
Thread

SPINNING JENNY is a machine for spinning yarn. Like the spinning wheel, it may be operated by a foot treadle or by hand. But the spinning jenny can spin more than one yarn at a time. The idea for multiple-yarn spinning was conceived about 1764 by James Hargreaves, an English spinner. He noticed that the upright spindle of an overturned spinning wheel continued to revolve. In 1770, Hargreaves patented a machine that was capable of spinning 16 yarns at one time. ERNEST R. KASWELL

See also HARGREAVES, JAMES (with picture).

SPINOZA, *spih NOH zuh,* **BARUCH,** or BENEDICT (1632-1677), was a Dutch philosopher. He accepted René Descartes' idea that the universe is divided into mind and matter (see DESCARTES, RENÉ). But he saw, as Descartes did not, that if mind and matter are separate substances, they cannot interact. Spinoza decided that they are "attributes" of one substance, God. God, being infinite, has many attributes, but mind and matter are the only two that human minds can know.

Among the consequences of this view is the following: everything that exists, including individual men and women, is a part of God; in God, quite literally, we live and move and have our being. This view upset Spinoza's orthodox contemporaries, both Christian and Jewish, because it was so different from their own. The Jews denounced him and forced him to leave Amsterdam. Spinoza actually was deeply religious, and in many respects was a mystic. He held that man's highest happiness consists in coming to understand and appreciate the truth that he is a tiny part of an all-inclusive, pantheistic God (see PANTHEISM).

Culver

Baruch Spinoza

Spinoza was born in Amsterdam of Jewish parents who had sought refuge there from persecution. He broke with the Jewish faith after studying Descartes and Giordano Bruno. He prized independence and freedom of thought so much that he preferred to support himself by grinding lenses rather than accept a university professorship or financial aid. W. T. JONES

See also PHILOSOPHY (The Appeal to Reason).

SPINTHARISCOPE, or SCINTILLOSCOPE, is an instrument used to observe the flashes of alpha particles emitted from radioactive substances. The instrument consists of a brass tube with a zinc sulfide screen at one end, a lens at the other end, and a speck of radioactive material one millimeter from the screen. Sir William Crookes, an English chemist, developed the instrument in 1903 (see CROOKES, SIR WILLIAM).

SPINY ANTEATER. See ECHIDNA.

SPINY LOBSTER. See LOBSTER (The Body of a Lobster).

SPIRACLE. See FLY (Abdomen); INSECT (Respiratory System).

SPIRAEA, *spy REE uh,* is the name of a genus of herbs and shrubs in the rose family which bear white, pink, or rose-colored flowers. Spiraea grows in the temperate and cold regions of the Northern Hemisphere. Gardeners raise many species of spiraea as ornamental plants.

Walter Singer

Plum-Leaved Spiraea, commonly called bridal wreath, bears small clusters of dainty white flowers on slender stalks.

One of the best known is *Van Houtt's spiraea,* a hardy shrub with thick, deep green foliage. Another is *Thunberg's spiraea,* which has more delicate leaves. The *hardhack,* or *steeplebush,* can be planted in masses. Its flowers grow in narrow, crowded clusters. The *plum-leaved spiraea* is the well-known *bridal wreath* (see BRIDAL WREATH). It may grow more than 6 feet (1.8 meters) high, and has white flowers. Another well-known species is a troublesome weed called *meadowsweet.* It grows in New England. Spiraeas grow well in good land, but need much water and sunlight.

Scientific Classification. Spiraea belongs to the rose family, *Rosaceae.* Van Houtt's spiraea is genus *Spiraea,* species *S. vanhouttei.* Thunberg's is *S. thunbergii.* Hardhack is *S. tomentosa.* Bridal wreath is *S. prunifolia.* Meadowsweet is *S. latifolia.* J. J. LEVISON

SPIRAL NEBULAE. See NEBULA.

SPIRE is a term used in architecture to describe the pointed top of a tower or steeple. Most spires narrow to a sharp point high above the roofs of their towers. Many of them have eight sides. The spire developed from the *turret,* a small tower.

In early Christian times, tall peaked turrets were placed on many roofs. In the Middle Ages, it became customary to build turrets on top of large church towers. These turrets gradually became taller and more slender. Some of the greatest spires in the world rise above cathedrals in Europe. The spire of the cathedral of Ulm, Germany, rises 528 feet (161 meters) and is the highest in Europe. The spire of the cathedral at Cologne, Germany, rises 525 feet (160 meters). The spire of Salisbury Cathedral in England rises 404 feet (123 meters). Many famous skyscrapers in New York City and Chicago, especially those built between 1910 and 1930, are topped with spires. ALAN GOWANS

See also COLOGNE (picture); CATHEDRAL (pictures); RELIGION (picture).

SPIRILLUM. See BACTERIA (Shapes; picture).

SPIRIT LEVEL. See LEVEL.

SPIRIT OF ST. LOUIS. See LINDBERGH, CHARLES A.

SPIRIT OF '76 is a famous patriotic scene painted about 1875 by the American artist Archibald M. Willard. The scene shows a fife player and two drummers leading American troops during a battle in the Revolutionary War. Willard painted several versions of *The Spirit of '76.* One of them appears in the WORLD BOOK article on REVOLUTIONARY WAR IN AMERICA.

Willard first drew *The Spirit of '76* as a humorous sketch called "Yankee Doodle." The sketch showed three army recruits parading through their training camp playing drums and a fife. Later, Willard painted a serious version of the sketch that was displayed at the Philadelphia Centennial Exhibition of 1876. Willard used friends and relatives as models in the various versions of the painting. EDWARD H. DWIGHT

SPIRIT WRESTLERS. See DOUKHOBORS.

SPIRITUAL is a type of religious song made famous by the Negroes of the Southern United States. The spirituals have a strong rhythm and are emotional. They are especially moving when sung by a group. A leader sometimes sings one or two lines alone, and a chorus comes in with the refrain. Spiritual singers often emphasize the rhythm by clapping their hands. Spirituals have been called the only truly American folk songs.

The melodies used in spirituals are sometimes said to have come from Africa. But there are spirituals which have no relation whatever to African songs. These spirituals show a direct relation to the results of evangelistic preaching among the poor whites in the South. These "revivals" also encouraged "white spirituals." The Negroes' love for song led them to put their feelings into their singing. Much of the ship loading and plantation work was accompanied by singing of spirituals.

The slaves based most of their spirituals upon characters and stories from the Bible. The manner in which these stories are told in Negro spirituals shows a colorful imagination and a simple faith. Many slaves thought of themselves as modern children of Israel and looked for a black Moses to deliver them from their bondage. Their songs were warmly appealing and sincere. Among the well-known spirituals are "Go Down, Moses," "Weeping Mary," and "Swing Low, Sweet Chariot."

Spirituals were little known outside the Southern States until after the Negro was freed from slavery. In 1867, William Francis Allen and Lucy McKim Garrison published a collection of Negro music called *Slave Songs.* The songs included "Climb Jacob's Ladder," "Give Me Jesus," and "I'll Take the Wings of the Morning."

In 1871, spirituals were introduced to other parts of the United States by a group of Negroes called the Jubilee Singers, of Fisk University, Nashville, Tenn. They traveled throughout the United States, and to England and Germany, giving concerts to raise money for their school. Within three years they collected $150,000. Other Negro schools followed their example. The Negro quartets from Hampton Institute in Virginia and Tuskegee Institute in Alabama became famous.

Spirituals are now one of the best-known forms of American music. Such famous singers as Marian Anderson and Roland Hayes have helped to accomplish this. Their influence can be heard in the opera *Porgy and Bess* by George Gershwin. RAYMOND KENDALL

See also FOLK MUSIC (picture).

SPIRITUAL VALUES. See PHILOSOPHY (What Is Good and What Is Evil?); ETHICS.

SPIRITUALISM, in religious philosophy, teaches the existence of a being or reality distinct from matter. This being may be called mind or spirit. Some persons believe that the mind, or spirit, is the only reality. This belief is called *spiritual idealism.* See also IDEALISM.

SPIRITUALISTS are people who believe that there are spirits of the dead and that some persons can communicate with them. Contact with the dead supposedly is established through persons called *mediums.*

Mediums may contact spirits at public or private gatherings called *séances.* During a séance, the medium and several other persons generally sit at a table. The members of the group may hold or touch hands. They concentrate their thoughts on the dead person whom they wish to contact, in most cases a friend or relative of one of the participants. The spirit of this person supposedly may show its presence by making rapping sounds or by raising or otherwise moving the table. The spirit may throw things about the room or make objects appear, disappear, or float through the air. A medium who carries on such a séance is called a *physical medium.*

Little physical action occurs during a séance conducted by a *mental medium.* Often, the medium enters a trance as the spirit supposedly seizes control of his body and mind. The spirit may speak to the séance through the medium, or it may "write" a message by guiding the medium's hand. Some mediums claim to have a special relationship with one particular spirit. This spirit, called the medium's *control,* speaks through the medium and relays messages from the dead person to the group.

Many scientists and others dispute the claims of spiritualists. It has been shown that mediums trick people at séances into believing that spirits can communicate with the living. Scientists offer explanations for much of what happens at séances. For example, some mediums are ventriloquists. Some use helpers and various types of trick equipment. Others use hypnosis. Many people who attend séances have a strong desire to contact a dead loved one. This desire may make them believe that any message delivered by the medium comes from the spirit world.

Many people believe sincerely in spiritualism. A number of them regard it as an authentic religion based on moral and philosophical principles. Some of these spiritualists also consider themselves Christians. However, several Christian churches declare that any attempt to call a spirit back to the earth is a sin.

Spiritualist Organizations. Some spiritualists are organized into churches. Some groups practice what they call *spiritual healing* of the sick. Some give advice to those who come to them with problems, and others work to spread spiritualism throughout the world.

The chief spiritualist organizations in the United States include (1) the International General Assembly of Spiritualists, (2) the National Spiritual Alliance of the U.S.A., (3) the National Spiritual Association, (4) the National Spiritualist Association of Churches, and (5) the Progressive Spiritual Church. For the U.S. mem-

bership of the International General Assembly of Spiritualists, see RELIGION (table). Most of the other spiritualist groups do not give out membership figures.

History of Spiritualism. Some spiritualist practices date from ancient times. The Old Testament tells that the Hebrew king Saul consulted a medium, the witch of Endor. Through the medium, Saul questioned the spirit of the dead prophet Samuel about an upcoming battle against the Philistines.

The modern spiritualist movement began in 1848 with Katherine and Margaret Fox, two little sisters from Hydesville, N.Y., near Rochester. The girls claimed they had communicated with the spirit of a man who they said had been murdered in their house. The spirit supposedly answered their questions through a code of rapping sounds. The girls' story attracted wide publicity and made them world famous. They later confessed that they had made the sounds themselves by tapping on the floor.

In the late 1800's, the American psychologist William James studied the case of Mrs. Leonora Piper, a Boston housewife who experienced hypnotic trances. The spirits of such famous persons as the composer Johann Sebastian Bach and the poet Henry Wadsworth Longfellow seemed to compete for control of her mind. In 1964, Mrs. Rosemary Brown, a London factory worker, recorded music that she said had just been composed by the spirits of Bach and other composers. Some scientists dismiss such cases as trickery. Others admit that such occurrences cannot be fully explained.

Today, communication with the dead through mediums plays an important part in the religion of many peoples. Among these are groups who live in Africa and on several Pacific islands. They also include some American Indian groups. ERIKA BOURGUIGNON

See also ECTOPLASM; GHOST.

SPIROCHETE. See RELAPSING FEVER; VENEREAL DISEASE; YAWS.

SPIROGYRA is the name of a group of fresh-water green algae that form slimy scum in still water.

SPIROMETER, *spy RAHM ee ter*, is a device that doctors use to measure how much oxygen a person's body uses. It also measures how much air the lungs can hold, how well the lungs are working, and the number of times a person breathes each minute.

A spirometer is made up of two cylinders. One cylinder is upside down and rests inside a larger cylinder that is filled with water. The patient breathes through a rubber tube into the inner cylinder. The added air causes the cylinder to rise in the water. When the patient inhales, he removes air from the cylinder and it sinks. A writing arm records these movements on a piece of paper. This record is called a *spirogram*.

The spirometer is most often used to measure a person's *basal metabolic rate* (the amount of oxygen the body uses while at rest). Certain diseases, especially those of the thyroid gland, cause the basal metabolic rate to change. To measure how much air the lungs can hold, the patient first breathes in as deeply as possible, and then exhales as much air as possible into the spirometer. The amount of air that was exhaled is called the *vital capacity*. The vital capacity is less than normal if a person has such disorders as asthma or certain heart diseases. E. CLINTON TEXTER, JR.

See also METABOLISM (Basal Metabolism).

SPITSBERGEN. See SVALBARD.

SPITTELER, *SHPIT uh ler*, **CARL** (1845-1924), a Swiss poet and writer, won the 1919 Nobel prize for literature. His main theme in the epic poem *Olympic Spring* (1900-1910), and in his other writings, is the suffering of man. He believed that suffering cannot be overcome, but that it can be reduced by the kind acts of noble men. He was born in Liestal. GOTTFRIED F. MERKEL

SPITZ is a name given to several breeds of small dogs. The American spitz belongs to the spitz family of Arctic dogs, which includes the chow chow, Pomeranian, and Samoyed. The spitz weighs about 25 pounds (11 kilograms), and has a thick white coat, pointed ears, and a sturdy body. Its tail curls up over its back. The spitz is not recognized as a breed by the American Kennel Club. See also SAMOYED; POMERANIAN. OLGA DAKAN

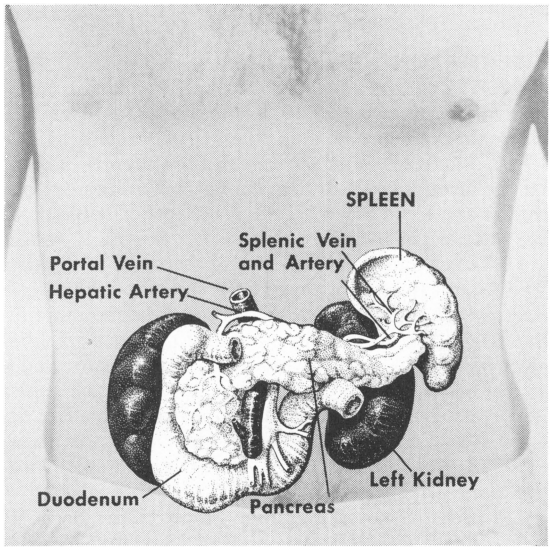
SPITZ, MARK. See OLYMPIC GAMES (table: Swimming and Diving [Men]).

SPLEEN is a large, glandlike organ in the body. It helps filter the blood. The spleen lies below the diaphragm, to the left of the stomach and a little behind it. In adults it is about 5 inches (13 centimeters) long and 3 to 4 inches (8 to 10 centimeters) wide, and weighs about 7 ounces (200 grams). It is soft and spongy, crumbles easily, and has a deep violet-red color. The organ is covered by a fold of the *peritoneum*, the membrane that lines the abdominal cavity. The principal cells of the spleen are similar to those in the lymph glands.

The spleen helps filter foreign substances from the blood, much as a lymph gland filters foreign substances from the lymph. Various kinds of cells in the spleen *engulf* (surround and destroy) these foreign substances. The spleen also serves as a "graveyard" for injured red blood cells. When the body needs extra blood during exercise or hemorrhage, the spleen contracts and squeezes out some of the blood cells it has stored. It may

Army Medical Center

The Spirometer Test shows how much air can be held in the patient's lungs. After he has inhaled as much as possible, he exhales the air through the tube. The lung capacity is determined by the distance the inside cylinder rises.



The Spleen aids the human body by acting as a blood filter. It also stores up blood cells that can be used in emergencies.

form red blood cells in unborn babies, but it does not do so after birth.

The spleen is thought to be only a helper of other glands and organs, for it may be removed from the body without any noticeable ill effects. It is often necessary to remove the spleen. Sometimes, a disease centers in the spleen and causes it to enlarge. In certain other diseases, the spleen works so hard at destroying worn-out red blood cells that it also destroys healthy red cells and causes anemia. Sometimes, it destroys blood platelets, which help in the clotting of blood. When too many platelets are destroyed, the patient may bleed into the tissues. In all these cases, the spleen has to be removed by a surgical operation. TERENCE A. ROGERS

See also HUMAN BODY (Trans-Vision three-dimensional color picture); IRON.

SPLICING is a method of joining two ends of rope or wire together without forming a knot. The strands of the ends are unraveled several turns. Then, the strands of one end are twisted around the strands of the other end. See also KNOTS, HITCHES, AND SPLICES (picture).

SPLIT, or SPALATO (pop. 114,000), is a seaport in Yugoslavia (see YUGOSLAVIA [color map]). It is a commercial and industrial center, and the chief city of the Dalmatian coastal area. Split is an ancient Roman town. Part of it was originally built about A.D. 295, within the walls of the palace of Emperor Diocletian. The palace is one of the finest examples of Roman architecture still standing. GEORGE KISH

SPLIT INFINITIVE. See INFINITIVE.

SPOCK, BENJAMIN McLANE (1903-), an American doctor, became famous for his books on child care. His best-known book, *Common Sense Book of Baby and Child Care* (1946), was translated into more than 25 languages. His other books include *Feeding Your Baby and Child* (1955), *Baby's First Year* (1955), *Dr. Spock Talks with Mothers* (1961), *Problems of Parents* (1962), and *Caring for Your Disabled Child* (1965).

In the 1960's, Spock became an active opponent of United States involvement in the Vietnam War. In 1968, he was convicted on charges of conspiring to counsel young men to avoid the military draft. He appealed the verdict. In 1969, the U.S. First Circuit Court of Appeals reversed his conviction.

Spock was born in New Haven, Conn. He graduated from Yale University and received his medical degree from Columbia University. JOHN A. BARBOUR

SPODE was the family name of three famous English pottery makers, father, son, and grandson.

Josiah Spode (1733-1797), the father, produced blue and white earthenware and transfer-printed willow-ware. He was apprenticed to Thomas Wheildon, became a master potter, and started his own shop.

Josiah Spode (1754-1827), the son, perfected the formula for bone china (see PORCELAIN [Kinds of Porcelain]). He also designed blue and gold tableware pottery in the style of Oriental porcelains. He was born in Stoke-on-Trent.

Josiah Spode (1776-1829), was the grandson. In 1827, he and William Copeland managed the Spode works, which fell to Copeland at Spode's death. Spode was born in London. EUGENE F. BUNKER, JR.

SPOHR, *shpohr*, **LOUIS** (1784-1859), was a German violinist, composer, and conductor. His works include the *Violin School* and the opera *Jessonda*. Spohr was born in Brunswick, Germany, and began to study the violin at the age of five. The Duke of Brunswick became his patron eight years later, and Spohr soon became a violin soloist. He started conducting in 1809, and later became court conductor for life in Kassel, Germany. IRVING KOLODIN

SPOILS SYSTEM uses public offices as political rewards for party services. The system is used in many countries. When a new political party comes to power, its leaders place many of their faithful followers in important government offices. Many people consider this justifiable when a party places able persons in high offices where policy is to be made. They feel the victorious party must shape policies to satisfy its supporters. It is unjustifiable when political leaders dismiss able persons from positions not of a policy-making type. They do this to make room for others whose chief or only merit consists of their having demonstrated they are "good party men." This makes government less efficient.

It was once widely thought that the spoils system in the United States first came into general use during the presidency of Andrew Jackson. Recent studies show that President Thomas Jefferson, a Democratic-Republican, followed a policy of not appointing Federalists to government offices. However, Jackson's friend, William L. Marcy, popularized the slogan "to the victor belong the spoils of the enemy."

By 1840, the spoils system was widely used in federal, state, and local governments. In 1883, a civil service law made it illegal to fill some federal offices by the spoils system. Since then, much has been done to avoid the evils of the system. Federal civil service legislation has been greatly expanded. Many cities and states have made education and experience the basis of appointment to public office. ROBERT A. DAHL

See also CIVIL SERVICE (History); GRANT, ULYSSES S. (Political Corruption); JACKSON, ANDREW (The Spoils System).

Spokane Chamber of Commerce

Spokane, Wash., Lies in the Level Spokane River Valley at the Foot of Steep, Pine-Covered Hills.

SPOKANE, *spoh KAN*, Wash. (pop. 170,516; met. area 287,487), is an important commercial center in eastern Washington. It ranks second to Seattle as the state's largest city. Spokane serves as the transportation and distribution center of the *Inland Empire*. This rich agricultural, lumbering, and mining area covers part of eastern Washington, northern Idaho, western Montana, and northeastern Oregon. Spokane lies about 15 miles (24 kilometers) west of the Idaho border. For location, see WASHINGTON (political map).

In 1810, the Canadian North West Company established a fur trading post called Spokane House near what is now Spokane. Permanent settlers came to the area in 1871. They were attracted by the falls of the Spokane River as a possible source of water power. The people named their settlement Spokane Falls. The word *Spokane* is the name of an Indian tribe that lived in the area.

Description. Spokane, the county seat of Spokane County, covers about 50 square miles (130 square kilometers). Two waterfalls in the center of the city furnish hydroelectric power and add to Spokane's scenic beauty. The Pacific Northwest Indian Center in Spokane features manuscripts and displays related to Indian culture, and exhibits of Western art. Other attractions of the city include the Cheney Cowles Memorial Museum, the Fort Wright College Museum, and the Grace Campbell Memorial Museum. Spokane has a symphony orchestra. Educational institutions in the city include Fort Wright College, Gonzaga University, and Whitworth College.

Economy. About 20 per cent of the workers in the Spokane metropolitan area are employed in wholesale and retail trade, more than in any other field. Spokane has about 245 manufacturing plants. The city's leading industries produce, in order of value, primary metal products, food products, printed materials, fabricated metal goods, and lumber and wood products. Spokane has the largest aluminum rolling plant west of the Mississippi River.

Spokane International Airport lies southwest of the city. Passenger and freight trains also serve Spokane.

Government and History. Spokane has a council-manager form of government. The voters elect a mayor and six council members, all to four-year terms. The council hires a city manager to carry out its policies.

Spokane Indians lived in what is now the Spokane area when white men first arrived there in the early 1800's. Spokane Falls was founded in 1871. A railroad first reached the community in 1881, and Spokane Falls also received a city charter that year. The discovery of silver and other minerals in the area attracted new settlers and businesses. A fire destroyed the city's business district in 1889, but the people rebuilt their community. They renamed it Spokane in 1891.

During the late 1890's, Spokane grew as a railroad center. New silver and lead mines opened nearby during the early 1900's and increased Spokane's importance as a mining community. Immigrants from Europe helped boost the city's population from 36,848 in 1900 to 104,402 in 1910. During World War II (1939-1945), Spokane served as a base for training pilots and as a center of aluminum production. The city's population reached 181,608 in 1960, but many people moved to suburban areas during the 1960's.

In 1974, Spokane held a world's fair called Expo '74. Many redevelopment projects were carried out before the fair. They included the construction of banks, department stores, and office buildings. Several structures built for the fair became permanent features of Spokane, including an auditorium for the performing arts and a convention center. JAMES L. BRACKEN

For the monthly weather in Spokane, see WASHINGTON (Climate).

SPONGE

SPONGE, *spuhnj*, is a water animal. At one time, people thought sponges were plants, because sponges are attached to the bottom of the ocean and do not move around. Many sponges look like a type of plant. But zoologists classify sponges as animals.

Sponges make up the animal phylum *Porifera*, which means *pore-bearers*. The surface of the sponge's body is covered with tiny pores.

Most sponges live in the ocean. But there are a few fresh-water *species* (kinds). Sponges can be found both in shallow and in deep water. They inhabit all the seas, but more kinds and numbers of sponges live in the warm temperate and tropical waters than anywhere else. The largest sponges, including the well-known commercial sponges that people use for cleaning, grow in these warmer waters.

Robert D. Barnes, the contributor of this article, is Professor of Biology at Gettysburg College; and the author of Invertebrate Zoology.

Sponges have lived from the earliest ages. Scientists have found remains of sponges in the oldest rocks that bear fossils.

The Body of the Sponge

A sponge does not look like any other animal. Some sponges are shaped like vases or goblets, but most species of sponges have no definite shapes. Some may be thin and flat, while others become round masses. Still others may look like branching shrubbery or treelike bushes. Sponges vary greatly in size. Some grow to less than 1 inch (2.5 centimeters), while others grow to more than 4 feet (1.2 meters).

A sponge has no head, mouth, or internal organs. It depends on a system of water canals in its body to bring in food and oxygen. This system also carries away waste products.

Tiny pores in the surface of the sponge's body lead to the tiny canals. Food and oxygen enter the body through the pores, and are carried through the canals into small chambers. These are called *flagellated chambers*, because each cell that lines them contains a *flagellum* (long thread that whips around to aid movement). The flagellated chambers drain into other small canals. These canals join a network of small canals that eventually lead to the outside through a large opening in the sponge's body called the *osculum*.

A piece of sponge as small as a marble contains thousands of flagellated chambers and canals. Symmetrical sponges with vase-shaped or goblet-shaped bodies have only one osculum. Sponges with bodies that are not symmetrical have many oscula, each providing an exit from the thousands of flagellated chambers and canals. Many zoologists believe that a sponge with many oscula is not a single animal, but a colony made up of many sponges.

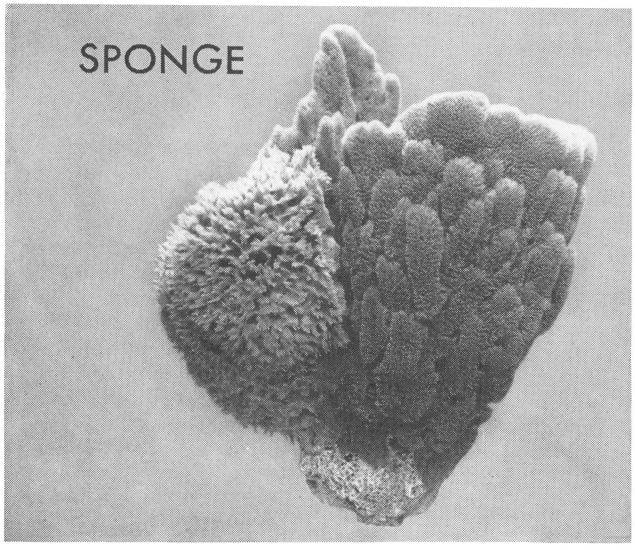
The beating, whiplike movements of the flagella circulate water through the sponge. Water enters through the sponge's surface pores. It flows through the flagellated chambers and canals and moves out through the osculum. The water sweeps tiny plants and animals into the sponge and through its body. When these food particles reach the flagellated chambers of the sponge, the cells that line the chambers *engulf* (surround) and digest them.

Sponges have several types of skeletons. Some sponge skeletons consist of tiny needles, called *spicules*. Other skeletons are made of fibers, called *spongin*. Some sponges have skeletons that consist of both spicules and spongin. There are two kinds of spicules in sponge skeletons. Some skeletons have spicules made of *cal-*

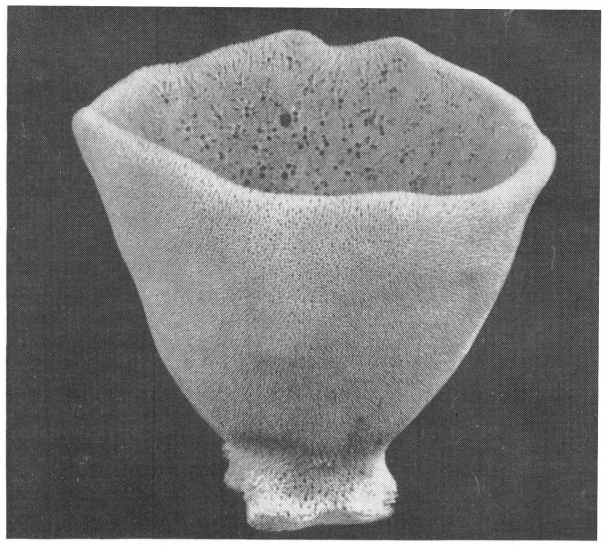
Wide World

A Sponge Diver gathers live sponges from the bottom of the sea and brings them to his ship to dry. His diving gear enables him to descend 100 feet (30 meters).

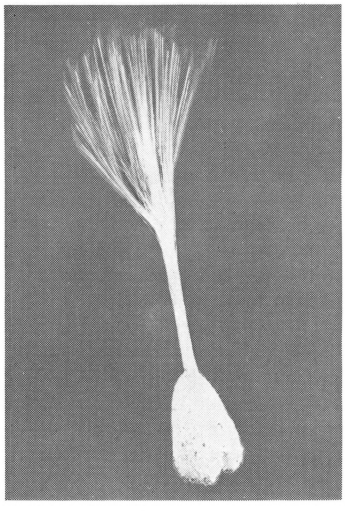
SPONGE



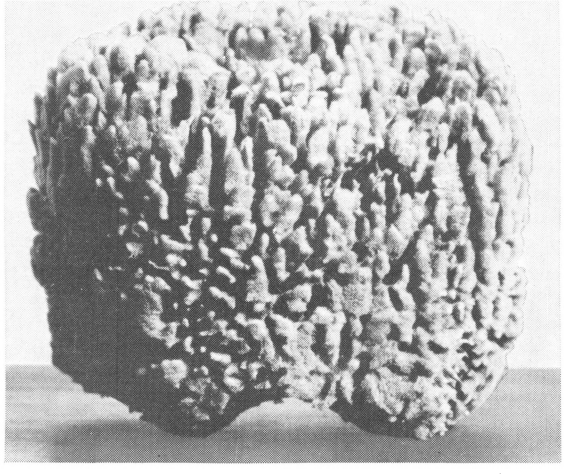
Sheepswool and Grass Sponges grow from the same base, *above*. They grow side by side but they are quite different.



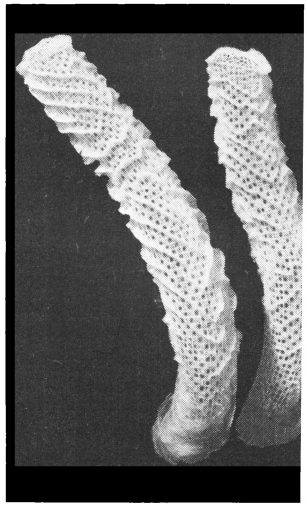
The Horny Sponge, or Elephant-Ear, from the Mediterranean Sea has a very fine texture. It is used commercially.



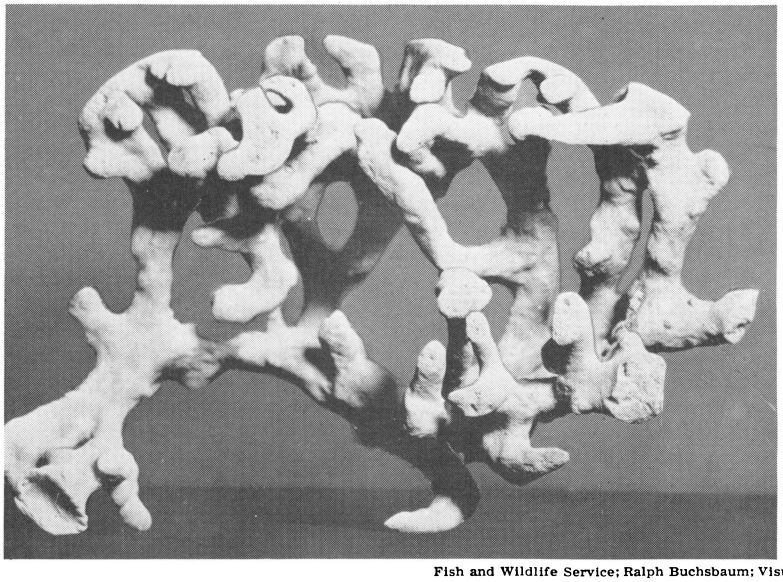
The Glassrope Sponge is a native of the Indian Ocean.



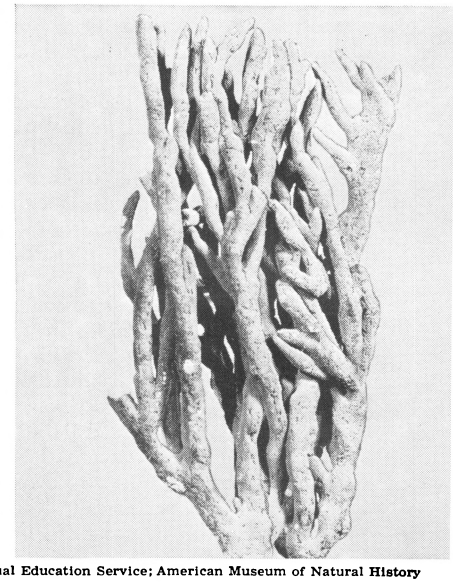
The Velvet Sponge lacks the finer texture of the sheepswool sponge, but it is satisfactory for rougher cleaning work.



Venus's-Flower-Basket has a skeleton of fine lacework.



This Section of a Growing Sponge shows the strange branchlike formation the sponge follows as it enlarges.



This Sponge Growth is like closely twined branches of a gnarled tree.

Fish and Wildlife Service; Ralph Buchsbaum; Visual Education Service; American Museum of Natural History

cium carbonate (limestone). Others have spicules made of *silica* (glass).

All sponge skeletons form a supporting meshwork throughout the sponge's body. *Glass sponges* contain skeletons made of evenly arranged glass spicules. After the sponge cells are removed these beautiful skeletons look like glass wool. The delicate *Venus's-flower-basket* is a glass sponge. Other less attractive sponges leave only the rough spongin fibers after the cells have been removed.

Living ocean sponges may be black, brown, gray, or brilliant shades of red, blue, purple, and yellow. Freshwater sponges are green in color, because *algae* (microscopic plants) live in some of the sponges' cells.

Life Story of the Sponge

The sponge may begin life as a single cell, an egg. This egg divides inside the body of the parent, and keeps dividing until it forms a tiny *larva* (undeveloped animal form) covered with flagellated cells. Then the water circulating through the parent's body sweeps the larva outside the body. The tiny larva is on its own. Its beating, lashing flagella move the larva through the water until it finally settles to the bottom of the ocean and attaches itself to a hard surface. The larva develops into an adult sponge there.

Sponges may also reproduce *asexually* (without eggs). They do this by growing buds and branches that eventually break away from the parent sponge and grow into new sponges on their own.

Sponges have remarkable powers of *regeneration* (regrowth of body parts). Even if much of the body breaks or is cut away, the sponge can replace the broken parts. To test these powers of regeneration, zoologists have pressed sponges through extremely fine cloths so that all the cells of the sponge separate or divide into small groups. When the zoologists put the cells back into water again, the cells rearrange themselves to form a new sponge.

Commercial Sponges

Most of the so-called *sponges* sold in stores today are not true sponges. They are synthetic materials made to look and to clean like true animal sponges. Skeletons used as true commercial sponges consist of soft, elastic spongin fibers. They are free from impurities and can absorb large amounts of water. These qualities make sponges excellent cleaning tools.

True commercial sponges come from Tarpon Springs off Florida's west coast, and from waters off Key West, the Bahamas, and Cuba. Sponges are also taken from the Mediterranean Sea off the coasts of Egypt, Greece, Tunisia, and Turkey. The silk cup sponge, found off Egypt and Greece, ranks as the most valuable of all commercial animal sponges. Other valuable commercial animal sponges include the elephant-ear, the honeycomb, and the Rock Island wools.

Sponge fishermen use several different methods to get sponges. In the deeper waters of the Mediterranean Sea, fishermen in diving suits go down after the sponges. Sometimes they use dredges to bring them up. In the shallow waters off the coast of Florida, fishermen use the *hooking* method. Two men go out in a glass-bottom boat. One man manages the boat while the other does the fishing. The men look through the glass bottom of the boat and can see 50 feet (15 meters) or more below the surface. A fisherman lowers a long pole with a pronged hook to where the sponges are. He uses the hook to loosen the sponges and bring them to the surface. In the deeper waters of the Gulf of Mexico, sponge fishermen use diving suits. Sometimes they go down 100 feet (30 meters) or deeper to reach the sponges.

Fishermen spread the sponges out on deck until the flesh decays. After all the decaying substances are removed, the fishermen hang the skeletons in the rigging of the ship to dry. Shallow-water fishermen keep their catch in *kraals* (pens) along the shore. The high tide fills these pens with water, removing the flesh and leaving the skeleton.

Scientific Classification. Sponges make up the animal phylum *Porifera*. There are three classes of sponges. Sponges with limestone spicules belong to the class *Calcarea*. Glass sponges belong to the class *Hexactinellida*. The largest class is the class *Demospongiae*. These sponges can have glass spicules, spongin fibers, or both types of skeletal materials. ROBERT D. BARNES

See also FLORIDA (color picture: Diving for Sponges); OCEAN (color picture: Benthos).

SPONGE RUBBER. See RUBBER (Sponge Rubber).

SPONSOR, in baptism. See BAPTISM.

SPONTANEOUS COMBUSTION is burning that begins without the application of a flame. It takes place when oxygen in the air unites with coal, oil, or other inflammable substances. This reaction raises the temperature of the material until it gets so hot that it bursts into flame. See also COMBUSTION (Spontaneous Combustion).

SPONTANEOUS GENERATION, or ABIOGENESIS, *AB ee oh GEN uh sis*, is a theory that certain low forms of living matter came into being from nonliving material. This theory started among the ancient peoples, who believed that such living things as insects and mice came to life from the mud where they were found in large numbers. They also believed that worms came from cheese and wood, and maggots from the juices of decaying meat. Later, scientific experiments disproved this theory. In 1668, an Italian biologist, Francesco Redi, proved that maggots would not breed in meat in which flies were kept from laying eggs. He showed that complex creatures were produced only by others like themselves. Later, when scientists discovered bacteria and other microorganisms, the problem of their beginnings came up again. In the middle of the 1800's, Louis Pasteur completely disproved the theory of spontaneous generation. He showed that bacteria would not grow in materials which were sterilized. Today, biologists believe that all complex living matter comes from other living matter.

Some biologists also believe that it is possible that the very lowest forms may have developed through chemical processes from nonliving matter. But no one has ever demonstrated or proved this development under satisfactorily controlled conditions. GEORGE W. BEADLE

See also LIFE (The Origin of Life [Early Theories]); BIOGENESIS.

SPOOL FURNITURE. See FURNITURE (American Furniture [Spool]).

SPOON. See KNIFE, FORK, AND SPOON.

SPOON-BILLED CATFISH. See PADDLEFISH.

SPOON RIVER. See ILLINOIS (Rivers and Lakes).

SPOONBILL. See SHOVELER.

SPOONBILL is a wading bird which looks like an ibis. It has an odd, spoon-shaped bill, which it swings from side to side in the water in search of shellfish, water insects, and small crabs. The *roseate spoonbill* lives in the warmer regions of the Americas. The neck and the upper back of this bird are white. The other feathers are rosy pink, turning to red on the outer part of the wings. The roseate spoonbill nests in colonies, and returns year after year to the same place. The nest is a platform of sticks, placed in low trees or shrubs. The female lays 5 to 7 eggs, which are spotted and blotched with olive brown. The finest colonies in the United States are on islands in the Gulf of Mexico.

Scientific Classification. The spoonbills belong to the ibis family, *Threskiornithidea*. The roseate spoonbill is genus *Ajaia*, species *A. ajaja*. ALFRED M. BAILEY

See also BIRD (picture: Types of Beaks; color picture: Water Birds).

SPORE is a tiny one-celled body that is able to grow into a new organism. It takes the place of the seed of higher plants. Spores are produced primarily by lower plants, such as the algae, fungi, and bacteria. They may be produced by certain green plants that do not bear seeds, such as ferns and mosses. Certain *protozoa* (one-celled animals) of the class *Sporozoa* also form spores.

The spore is so tiny that it can be seen only through a microscope. It is made up of one cell which contains living matter known as *protoplasm*. The cell contains food materials which aid it to grow into a new organism.

There are two types of spores. One type of spore is known as the *sexual*, or *perfect*, spore because it is formed by the union of the so-called male and female sex cells. The second type of spore is formed in various ways without the use of the so-called sex cells. This type of spore is known as the *asexual*, or *imperfect*, spore. The spores of many fungus plants cause disease in crops. There are spores which cause corn smut, cotton wilt, wheat rust, and apple blight. Certain spore-producing, one-celled animals may also cause diseases in human beings. WILLIAM C. BEAVER

SPOROPHORE. See MUSHROOM (Parts).

SPOROPHYTE. See BRYOPHYTE; LIVERWORT.

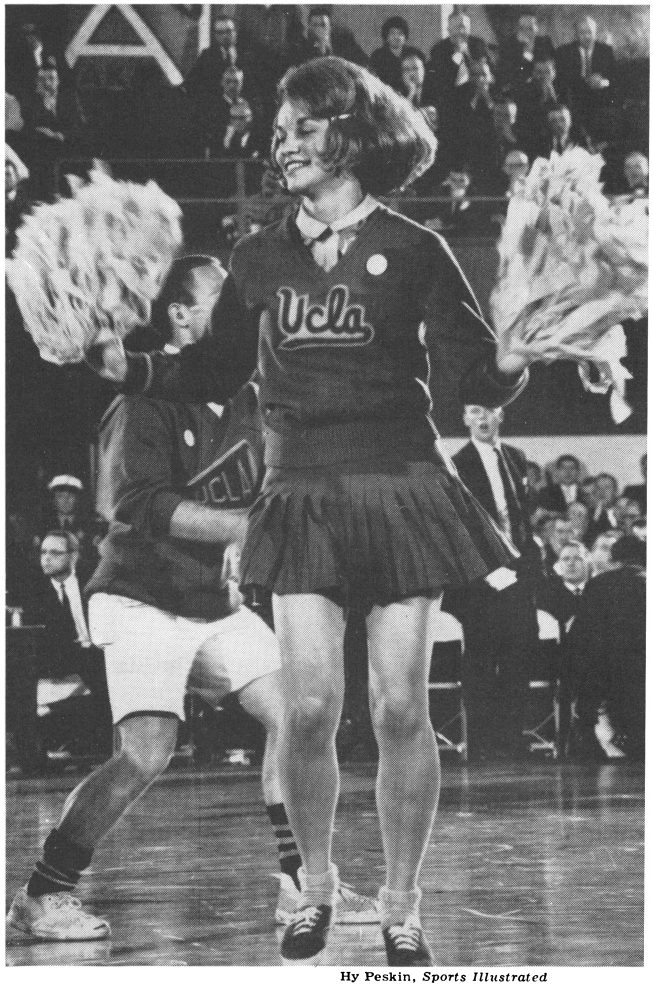
SPOROZOA. See PROTOZOAN.

SPORT is a term applied to the sudden appearance of certain new hereditary types in plants and animals. Sports are caused by changes in the cells called *mutations* (see MUTATION). The new types are often used as parents to produce new varieties or breeds.

Many plant mutations affect the whole plant. But sometimes the new mutation affects only one branch of the plant. This is known as a *bud sport*. The *variegated* (many-colored) foliage of some plants originated from bud mutations. The navel orange was developed from a bud mutation on an ordinary orange tree. Plant growers have used sports to produce many new plants. Among the new types are the Shirley poppy and the Cupid sweet pea. J. HERBERT TAYLOR

See also FLOWER (Flower Breeding); BREEDING; HEREDITY (Heredity and Evolution).

SPORTING DOGS. See DOG (table: Recognized Breeds; color picture: Sporting Dogs).



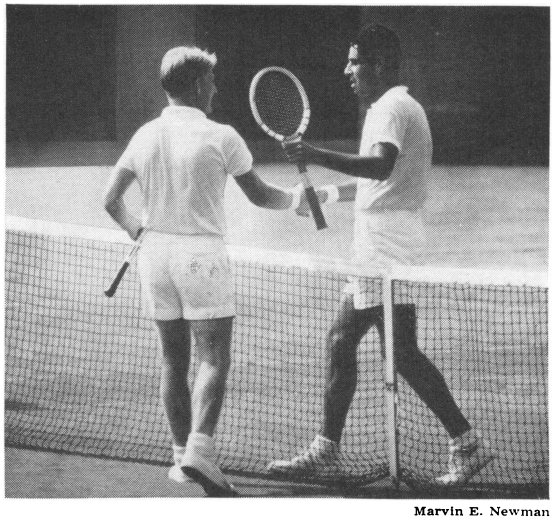
Hy Peskin, *Sports Illustrated*

Excited Cheerleaders symbolize the thrills that come from watching sports and taking part in them. Cheerleading demands the physical skill, enthusiasm, and teamwork found in many sports.

SPORTS AND SPORTSMANSHIP. Almost everyone likes sports. Next to the weather, people probably talk more about sports than about any other topic. We discuss a coming game, and after it is over we "replay" the excitement of a winning goal, a touchdown, or a home run. The wide appeal of sports is shown by the large amount of space given them in newspapers and magazines, and on television and radio.

Sports demand a combination of physical skill and strength, an alert mind, enthusiasm, purpose, and usually teamwork. They represent accomplishment for which the body must be trained, and for which a person must work to become skillful.

Many friendships are formed through sports. The ability of people to get along with each other receives one of its greatest tests in sports competition. But perhaps even more important are the qualities that sports develop in making a person well-adjusted to daily life. The term *sportsmanship* may be applied to life in general. We like persons who can win without boasting, and lose without offering excuses.



Marvin E. Newman

The Spirit of Good Sportsmanship is demonstrated by two tennis champions shaking hands across the net after a hard-fought game. Sportsmanship means being modest in victory as well as accepting defeat gracefully after trying your best.

Persons of all ages enjoy watching and taking part in sports. They crowd into stadiums to watch skilled athletes compete on teams sponsored by schools, colleges, recreation departments, and professional and private clubs. Other millions watch sports on television and listen to play-by-play reports on radio. Still others enjoy sports in back yards and vacant lots.

Almost any pleasant activity aimed at exercising the body may be called a sport. What is sport for one person may be just hard work for another. A city resident may find it sport to chop wood for a day. But such activity is merely daily work for a woodsman.

Sports become *athletics* when a person or a team competes against another, or when a team or person competes against a record or some other goal. The most popular athletic sports are baseball, basketball, boxing, football, golf, gymnastics, soccer, swimming, tennis, track and field, volleyball, and wrestling. Other sports include boating, bowling, camping, fishing, hiking, hunting, sailing, and skating.

Sports have provided a common meeting ground for boys and girls, and men and women, from all parts of the world. Every four years, athletes from many nations compete in the Olympic Games. In a spirit of peace and friendship, they battle for honors in all sports.

Sports are also an important business. Americans spend more than $4,000,000,000 each year to buy sporting equipment and to attend sports events.

Sportsmanship

Sportsmanship demands honesty, fair play, cooperation, competitive spirit, respect for authority and rules, acceptance of responsibility, and respect for others. The true sportsman plays hard in order to win, but respects his opponent and accepts defeat gracefully. A hunter who is a true sportsman observes game regulations and gives his quarry a fair chance.

A person does not have to be a skilled athlete or sportsman to practice sportsmanship. In fact, a less skilled athlete often has the best chance to show sportsmanship. A person can show good sportsmanship in many ways not connected with sports, because sportsmanship is an important part of good citizenship. A student who loses a class election shows good sportsmanship by congratulating the winner.

Perhaps one of the best definitions of sportsmanship is the code of sportsmanship of the Sportsmanship Brotherhood. Here are its rules.

1. Keep the rules.
2. Keep faith with your comrade.
3. Keep your temper.
4. Keep yourself fit.
5. Keep a stout heart in defeat.
6. Keep your pride under in victory.
7. Keep a sound soul, a clean mind, and a healthy body.
8. Play the game.

Types of Sports

Individual Sports are perhaps the oldest and most popular sports. They do not require a group or team of players. These sports include archery, bowling, golf, and swimming. Some individual sports, such as boxing, fencing, tennis, and wrestling, require an opponent. They are *dual*, or *combative*, sports. But in each case, the player competes as an individual. Nearly all individual sports can also be played by a team.

Combative Sports set one person against another in the keenest type of competition. Men and boys like to box, fence, and wrestle. School combative sports must be carefully planned and supervised, because young people cannot play combative sports in the same way as grown people.

Water Sports. Millions of people of all ages like to hunt, swim, dive, fish, go boating and sailing, try water skiing or skin diving, or just wade in the water. Public and private beaches and pools attract swimmers in the summer. Many schools have their own swimming pools.

Outdoor Sports are as old as civilization itself. Every member of the family can enjoy a camping trip, and more and more people are finding a renewed interest in this activity. Boys and girls can learn many things about nature and life from camping and hiking trips.

Team Sports. Thousands of men, women, boys, and girls enjoy playing baseball and basketball every year. Men and boys enjoy playing football, soccer, and ice hockey. Each of these sports requires close teamwork.

Amateur Sports

Amateur athletics are organized for most sports. They have rules for competition and standards that an athlete must follow in order to keep his amateur status. Amateur athletes do not receive pay for performing. In some contests, they receive money for expenses. Winners may also receive such prizes as medals, ribbons, trophies, and watches. Amateur athletic organizations include the United States Golf Association (USGA), the United States Lawn Tennis Association (USLTA), and the Bicycle Association of America.

Amateur sports outside schools and colleges are regulated by the Amateur Athletic Union of the United States (AAU), which was founded in 1888. The United States Olympic Committee, organized in 1896, selects the United States Olympic team. The Canadian Ama-

teur Sports and Physical Fitness Development Services is a program designed to increase interest in sports.

Professional Sports

Professional sports are played for financial profit. They developed when men decided to make a business of the more popular sports. Teams in professional baseball, basketball, football, and ice hockey spend large amounts of money for players. Several players earn more than $100,000 a year. Professionals also perform in such sports as bowling, golf, and tennis.

Most professional sports are regulated by associations of owners or promoters. The baseball, basketball, football, and ice hockey owners hire a commissioner (called president in hockey) to settle some disputes between teams and investigate incidents he believes may be harmful to the sport. Players have their own associations, which work to gain improved benefits for them.

Sports in the School

Elementary-School Sports. School sports programs usually start in the elementary grades. Most children become interested in competitive sports in about the fifth grade. They learn the fundamentals of team and individual sports. Many schools have organized teams in the higher elementary grades that compete against teams from other schools. Such athletic programs promote good health, sportsmanship, good personal habits, body development, and competitive spirit.

High-School Sports. Almost every state has a state high-school athletic association. These groups regulate all contests between high schools, and set the eligibility standards for all players. They also classify schools according to enrollment, to insure fair competition. When necessary, the association changes the rules of games so they may be played by students of high-school age. The state association also lists approved officials, and sets their fees. It decides on codes of conduct for coaches, players, and officials. The National Federation of State High-School Athletic Associations, organized in 1920, operates throughout the United States.

Four Canadian provinces—New Brunswick, Nova Scotia, Ontario, and Saskatchewan—have interscholastic athletic associations. All are affiliated with the U.S. national high school federation.

Intercollegiate Sports involve competition between students of two different schools. These sports enjoy great popularity. Football attracts more interest than any other college sport. Huge crowds jam stadiums in every part of the U.S. on fall weekends to watch college football teams play. Receipts from college football games help finance college teams in other sports.

College athletes must be amateurs. The National Collegiate Athletic Association (NCAA) provides national leadership in conducting intercollegiate sports.

Intramural Sports provide competition among students of the same school or college. A student usually does not have to be highly skilled to compete. Intramural sports provide spirited competition and recreation in such games as badminton, basketball, bowling, handball, softball, swimming, tennis, touch football, volleyball, and wrestling. Intramural teams are generally formed by classes, dormitories, fraternities, student clubs, and other student groups.

History of Sports

History shows that man played even in the earliest times. He gradually organized his play into games, and, as civilization developed, his games or sports developed. Early societies used sports to train people for survival and for war. Then, as people learned to live together more peacefully, sports festivals developed.

The Olympic Games became the most outstanding of the early sports festivals. The first recorded Olympic

Friends Magazine

Water Sports combine gleeful fun with healthy exercise. Outdoor and indoor pools make water sports possible the year around.

Chicago Today

Team Sports like baseball provide a valuable lesson in teamwork—the ability to work with others toward a common goal.

SPORTS CAR

Games took place in Greece in 776 B.C., and included many events such as the javelin throw that are still part of the Olympics. Sports developed slowly during the Middle Ages, but interest in them grew during the Renaissance and Reformation periods.

James A. Naismith, seeking a sport that could be played indoors and was not too rough, invented basketball. British soldiers developed ice hockey when they played field hockey on the frozen ponds of Canada. Youngsters in Boston and New York changed the rules of cricket and a game called *rounders* to suit themselves. Their game eventually became baseball.

Students led in developing many sports. They organized rugby, cricket, and soccer teams, and had rowing contests in early American colleges. Educators finally recognized the importance of sports in the total education of boys and girls, and play and exercise became part of the school program. WALTER HAROLD GREGG

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Bowling	Lacrosse	Speedball
Cricket	Lawn Bowling	Squash
Croquet	Little League Baseball	Table Tennis
Field Hockey	Pall-Mall	Tennis
Football	Polo	Volleyball

ICE AND SNOW SPORTS

Bobsledding	Hockey	Iceboating	Snowmobile
Curling	Ice Skating	Skiing	Tobogganing

WATER SPORTS

Aqua-planing	Canoeing	Sailing	Water Polo
Birling	Diving	Skin Diving	Water Skiing
Boating	Fishing	Surfing	Water Sports
	Rowing	Swimming	Yacht

OTHER SPORTS

Acrobatics	Horse Racing	Roller-Skating
Archery	Horseshoe Pitching	Hockey
Automobile Racing	Hot Rod	Shuffleboard
Badminton	Hunting	Skeet
Bicycle Racing	Judo	Skydiving
Boxing	Mountain Climbing	Spearfishing
Deck Tennis	Quoits	Track and Field
Falcon and Falconry	Racing	Trapping
Fencing	Roller Skating	Trapshooting
Glider		Weight Lifting
Hiking		Wrestling

SPORTS ORGANIZATIONS

Amateur Athletic Union of the United States	National Collegiate Athletic Association
American Bowling Congress	Sokol
Helms Athletic Foundation	Turnverein

OTHER RELATED ARTICLES

Ball	Handicap	Physical Education
Coach	Intramural Sports	Physical Fitness
Court	Madison Square Garden	Recreation
Game	Olympic Games	Stadium
Gymnasium	Pan American Games	

SPORTS CAR. See AUTOMOBILE (pictures: Sports Cars); AUTOMOBILE RACING (Sports Car Races).

SPOT is a popular sport fish ranging from 6 to 10 inches (15 to 25 centimeters) long and weighing about ½ pound (0.2 kilogram). Spots are silvery above and bluish below, with a small dark spot on the shoulder. The upper side has from 12 to 15 yellowish stripes. The spot is caught along the Atlantic and Gulf of Mexico coasts. It has great commercial value as a food.

Scientific Classification. The spot belongs to the croaker family, *Sciaenidae*. It is genus *Leiostomus*, species *L. xanthurus*. LEONARD P. SCHULTZ

SPOT MARKET. See COTTON (Selling).

SPOT REMOVING. See DRY CLEANING; CLEANING FLUID.

SPOTSWOOD, ALEXANDER (1676-1740), was a lieutenant governor of colonial Virginia. He took office in 1710. He tried to regulate the fur trade with the Indians, and favored the inspection of tobacco to prevent the export of inferior goods. Spotswood tried to protect the colony from Indian raids. He encouraged settlement along the colony's western frontier and led several expeditions over the Blue Ridge Mountains.

Spotswood quarreled with the council of the Virginia colony over many of his policies. He acquired an estate of about 85,000 acres (34,400 hectares) in Spotsylvania County, and retired there after being removed as lieutenant governor in 1722. He was appointed deputy postmaster general for the colonies in 1730. Spotswood was born in Tangier, Morocco. JOSEPH CARLYLE SITTERSON

SPOTSYLVANIA COURT HOUSE, BATTLE OF. See CIVIL WAR (Spotsylvania Court House).

SPOTTED ALDER. See WITCH HAZEL.

SPOTTED FEVER. See ROCKY MOUNTAIN SPOTTED FEVER.

SPOTTED TAIL (1823?-1881) was a leader of the Brulé Sioux Indians. He led his band against white settlers in the early 1860's but later supported peaceful relations between the Sioux and the whites.

In 1868, Spotted Tail and other Sioux leaders signed the Laramie Treaty preventing whites from occupying or building roads through Sioux territory. This region included parts of present-day North and South Dakota, Montana, and Wyoming. White miners violated the treaty when they poured into the Black Hills during the gold rush of 1874, and several Indian uprisings resulted. Spotted Tail did not take part in the fighting over the region and he worked for a peaceful solution. In 1876, the Sioux signed a treaty giving up the Black Hills in return for rations, schools, and other goods and services. In 1878, Spotted Tail and his people settled on the Rosebud reservation in what is now South Dakota.

Detail of oil painting on canvas (1887) by Henry Ulke; National Collection of Fine Arts, Smithsonian Institution, Washington, D.C.

Spotted Tail

Spotted Tail was born near Fort Laramie in Wyoming. The Sioux community college in Rosebud, S. Dak., has his Indian name, *Sinte Gleska*. BEATRICE MEDICINE

See also SOUTH DAKOTA (Territorial Days).

SPRAGUE, FRANK JULIAN (1857-1934), was an American electrical engineer and inventor. His inventions ranged from applications of electric power to theoretical problems of motors and generator design.

His work on electric-elevator and railroad motors, power supply, and *multiunit* control systems won him the title, "Father of Electric Traction." Sprague was born at Milford, Conn. See also ELECTRIC RAILROAD (History). ROBERT E. SCHOFIELD

SPRAIN is an injury to a ligament or to the tissue that covers a joint. Ligaments are bands of stringy fibers that hold the bones of a joint in proper position (see LIGAMENT). The tissue that covers the joint is called the *capsule*. Most sprains result from a sudden wrench that stretches or tears the tissues of the ligaments or capsule. Sprains of the ankle and wrist are most common, but a person may sprain any joint.

A sprain is usually extremely painful. The injured part often swells and turns black and blue. Doctors usually prescribe rest and elevation of the injured part. They may also apply cold compresses first, then warm compresses. They often use elastic bandages to reduce swelling and to provide support for the injured joint. BENJAMIN F. MILLER

SPRAT is one of the smallest sea fish in the herring family. It is only 3 to 6 inches (8 to 15 centimeters) long, and lives in shoals along the Atlantic and Mediterranean coasts of Europe. Sprats are often mistaken for young herring. But sprats can be recognized by the notched edge on the abdomen. They are a wholesome food. See also HERRING.

Scientific Classification. The European sprat is genus *Clupea*, species *C. sprattus*. LEONARD P. SCHULTZ

SPRAY GUN. See AIRBRUSH; PAINT (Spray Guns).

SPRAYING is a method of killing garden pests by means of a poisonous mist. Insect poisons are of two sorts, those that kill on contact, and those that the insect must eat in order to die.

Pyrethrum and nicotine sulfate are familiar contact poisons, and are often used on sucking insects. Arsenic salts, such as lead arsenate and calcium arsenate, are familiar stomach poisons used on caterpillars and beetles. Kerosene mixed with soapsuds kills some insects because it stops up their breathing pores.

Whatever the poison used for spraying, it must be made into a fine mist before it reaches the insects. This is done with a special kind of pump called a sprayer or with an *aerosol* (pressurized) container.

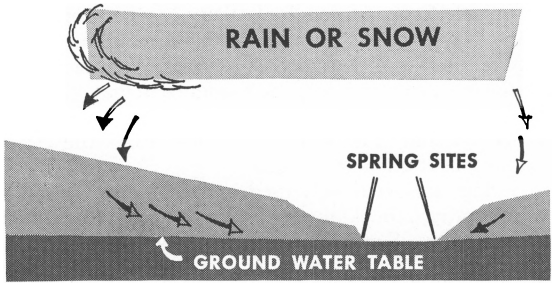
There should be little wind at the time when the spraying is done, for wind will blow the poison mist away before it can settle on the insects and their food. Spraying should not be done when there is a likelihood of rain within the next day or two because rain washes off the poison before it can do its work. W. V. MILLER

See also AEROSOL; FRUIT (Spraying); FUNGICIDE; INSECTICIDE.

SPREAD-EAGLEISM. See JINGO.

SPREE RIVER is a German waterway that passes through Berlin. It rises near New Salza in the state of Saxony, and flows across eastern Germany in a northerly direction for 220 miles (354 kilometers). It empties into the Havel River. About 50 miles (80 kilometers) upstream from Berlin, the Spree divides into many small streams, and cuts the land into hundreds of islands. Although the Spree is small, its water traffic is extensive. A canal links it to the Oder River. GEORGE KISH

SPRING is a natural source of water that flows from the ground. Water from rain and melting snow seeps into the ground. It filters through the pores and cracks in the soil into the layers of rock. The water finally reaches a layer through which it cannot pass. This water held underground is called *ground water* (see GROUND WATER). Gravity may force the water to rise until it finds a way out to the surface to form a spring.



Springs Form when *underground water*, or water from rain or snow that collects in the ground, finds a way to the surface. If the water finds a crack or channel in the rock, it rushes through. When it reaches ground level, the water bubbles forth.

Springs are found in mountains, hills, and valleys. They are often found at the foot of a cliff or slope or where a crack or fault reaches the surface (see FAULT). Hundreds of springs pour from the walls of the famous Snake River Canyon in Idaho.

The largest springs are found in limestone regions where the water flows underground in cavelike channels. Where such channels reach the surface, great quantities of water may pour from the ground. Famous limestone springs are found in Florida and Missouri.

The temperature of a spring depends on the temperature of the soil or rocks through which its water flows. Ground water that travels close to the surface may produce springs that are warmer in summer than in winter. Springs that come from farther down are always cold. However, deep down in the earth all rocks are hot. In volcanic regions hot rock may even lie close to the surface. As a result, spring water that has traveled from deep in the earth, or has originated in volcanic regions, is often hot.

Many springs contain minerals dissolved from the rock by the moving water. They are known as *mineral springs*. The belief that these springs relieve ailments has popularized them as health resorts. Examples of such health springs can be found in Mount Clemens, Mich., Saratoga Springs, N.Y.; Hot Springs National Park, Ark.; and in France. ELDRED D. WILSON

Related Articles in WORLD BOOK include:

Arkansas (Springs)
Florida (Rivers, Lakes, and Springs)
Geyser
Hot Springs
Idaho (Rivers, Waterfalls, Springs, and Lakes)
Mineral Water
Missouri (Springs and Caves)

SPRING is the quality of a material that causes it to "spring" back after being moved. A metal piece that resumes its shape after it has been bent is called a spring. Nearly all springs are made in the shape of a flat or cylindrical spiral, or are otherwise curved. The common materials used for springs are steel and bronze. Most materials have the quality of elasticity, which is the ability to resume a shape after being bent or pulled by

an outside force. Although elasticity can be exerted in many ways, springs are usually made to take advantage of the elasticity of torsion, or twist. When a length of wire is coiled, annealed, and hardened in that position, any effort to elongate or compress the coil causes a twist in its material. The spring promptly resists the compressing or stretching motions.

Springs are extensively used in machinery. We have watch springs, shock-absorber springs, door springs, and valve springs. Some springs react slowly in assuming their normal position after being compressed. Others, like the springs in a rifle, move out quickly when they are released. The rate of the return of a spring depends upon the force of return and the amount of material to be moved. Valve springs are the heart of a piston engine. They must retain their elasticity while hot and work for a long time without failure.

Adding alloys such as chromium, nickel, tungsten, and cobalt to steel wire used in springs increases their ability to withstand heat. Stainless-steel springs will perform well at temperatures up to about 500° F. (260° C). An alloy of nickel and chromium has been used at 900° F. (480° C). Jet and gas-turbine engines need springs that are able to withstand even greater temperatures. LOUIS MARICK

See also ELASTICITY; UPHOLSTERY (Springs).

SPRING is the season between winter and summer. The Northern Hemisphere, the northern half of the earth, has spring weather during late March, April, May, and early June. In the Southern Hemisphere, spring weather begins about September and ends by early December. For dates of the first day of spring and other information, see SEASON.

Spring weather begins in much of North America with the melting of winter snow. In the polar regions, spring weather begins later and does not last so long as in the middle parts of the Northern Hemisphere. Tropical regions do not have great seasonal changes.

The number of daylight hours increases during spring, and most spring days have higher temperatures than winter days. Nature awakens in spring, when flowers bloom and hibernating animals leave their winter sleeping places. In many countries, the people have festivals celebrating spring. JOHN E. KUTZBACH

See also MARCH; APRIL; MAY; JUNE; EQUINOX.

SPRING ARBOR COLLEGE. See UNIVERSITIES AND COLLEGES (table).

SPRING BALANCE. See BALANCE.

SPRING BEAUTY is the name of a wild flower that grows in forests from Nova Scotia to Georgia and from Saskatchewan to Texas. Its long, narrow leaves grow from a stem 6 to 12 inches (15 to 30 centimeters) high. It has two species. The more common Virginia type bears a white and pink flower with red veins. It blooms so early that many people call it Mayflower or good-morning-spring. The Carolina type has white blossoms.

Scientific Classification. The spring beauty belongs to the purslane family, *Portulacaceae*. The Virginia spring beauty is genus *Claytonia*, species *C. virginica*. The Carolina is *C. caroliniana*. GEORGE H. M. LAWRENCE

See also FLOWER (picture: Alaskan Spring Beauty).

SPRING HILL COLLEGE. See UNIVERSITIES AND COLLEGES (table).

N.Y. Zoological Society

The Springbok of Southern Africa is one of the most graceful and nimble members of the antelope family.

SPRINGBOK, or SPRINGBUCK, is an antelope that lives on the grassy and shrubby open plains of southern Africa. It gets its name from its habit of repeatedly springing up to 10 feet (3 meters) into the air when frightened, and then racing off at high speed. The springbok resembles the gazelle. A fringe of long white hairs in the middle of its back stands erect when the animal is frightened. Because of this trait, the Portuguese in Angola call this antelope the *goat of the fan.*

Slender and graceful, the springbok stands about $2\frac{1}{2}$ feet (76 centimeters) high and weighs from 70 to 80 pounds (32 to 36 kilograms). It is pale brownish-red, with a white face and white on its underparts and on the inner edges of its legs. Both male and female springboks have curved, lyre-shaped horns. The male horns may be from 14 to 17 inches (36 to 43 centimeters) long.

Wandering herds of springboks at times have ruined crops while seeking food and water. They have even lured whole herds of farm animals away with them. The Dutch settlers of South Africa called them *trekbokken* (traveling bucks). Hunters killed so many of them that large wild herds today can be found only in remote regions of Angola and Botswana.

Scientific Classification. Springboks belong to the cattle family, *Bovid*. They are classified as genus *Antidorcas*, species *A. marsupialis*. VICTOR H. CAHALANE

SPRINGER. See ARCH (picture).

SPRINGER SPANIEL. See SPANIEL; DOG (color picture: Sporting Dogs).

SPRINGFIELD, Ill. (pop. 91,753; met. area 171,020), is the state capital and the center of a rich farming region. It lies near a central Illinois coal field, 200 miles (320 kilometers) southwest of Chicago and 100 miles (160 kilometers) northeast of St. Louis (see ILLINOIS [political map]).

Industry. Springfield's products include boilers, earth-moving equipment, electric meters and electronic equipment, farm equipment, flour and cereal products, house and industrial paints, industrial tractors, mattresses, and soybean oil and meal. Springfield has been

a mining center since 1865. Lake Springfield, a large artificial lake, furnishes water for industrial purposes and for electric power. It also provides recreation.

History. Springfield was founded in 1818, and in 1821 was chosen as the county seat of Sangamon County. In 1837, it was designated the capital of Illinois, but the state offices were not moved there from Vandalia until 1839. It has a commission form of government.

The original statehouse, associated with Lincoln, Douglas, Grant, and other famous Illinoisans, is now a museum. It has been restored by the state of Illinois, and houses the Illinois State Historical Society. The cornerstone of the present Capitol was laid in 1868.

Abraham Lincoln lived in Springfield from 1837 to 1861. His home still stands at Eighth and Jackson streets, near the city's center. The Lincoln family lived in the two-story frame house from 1844 to 1861. In 1971, the home was designated a national historic site. Lincoln is buried in Springfield's Oak Ridge Cemetery. Larkin G. Mead designed Lincoln's tomb. It was dedicated in 1874. The state maintains the tomb.

The state maintains a Lincoln collection in the Illinois State Historical Library. In New Salem State Park, which is 20 miles (32 kilometers) northwest of Springfield, the pioneer village in which Lincoln lived from 1831 to 1837 has been reconstructed. PAUL M. ANGLE

See also ILLINOIS (picture: Illinois' Capitol); LINCOLN, ABRAHAM (pictures: Lincoln's Tomb, Lincoln's Home).

SPRINGFIELD, Mass. (pop. 163,905), is the third largest city in the state and the metropolis of western Massachusetts. It lies on the east bank of the Connecticut River, near the southern boundary of the state (see MASSACHUSETTS [political map]). With Chicopee and Holyoke, Springfield forms a metropolitan area with a population of 541,752. Springfield's city buildings stand in the Municipal Group. A 300-foot (91-meter) tower rises above the group. The city's park system covers about 2,000 acres (810 hectares).

Industry and Trade. Springfield has more than 300 factories. They produce adhesives and plastics, books, book matches, children's clothing, diesel fuel injectors, envelopes, firearms, forgings, games and toys, jet aircraft parts, machine tools, master clock systems, school supplies, and toasters and food mixers. The Springfield rifle of World War I, and the M1 of World War II, were developed in Springfield. Several large insurance companies have headquarters there.

The city is a transportation center for western New England. It serves as the Connecticut Valley's transshipment point for goods bound for New York City and the western parts of the United States.

Education and Culture. Springfield has about 30 public elementary schools and about 10 public junior and senior high schools. The city is the home of Springfield College, American International College, and Western New England College.

Springfield's cultural attractions are grouped in a city block called the *Quadrangle*. Included in the Quadrangle are the Springfield Museum of Fine Arts and the Museum of Natural History. The George Walter Vincent Smith Art Museum in the Quadrangle features Chinese porcelain and jade. The William Pynchon Memorial Building of the Connecticut Valley Historical Society displays colonial exhibits.

The Springfield Symphony Orchestra and the Young People's Symphony present many music programs throughout the year in Springfield. The Naismith Memorial Basketball Hall of Fame is at Springfield College.

History and Government. Pioneer William Pynchon led a group of settlers from Roxbury, near Boston, to the Connecticut Valley in 1636. The group settled first at Agawam on the western bank of the Connecticut River. Later, they moved across the Connecticut and settled on its eastern bank at the present site of Springfield. Indians attacked and burned the settlement during King Philip's War (1675-1676).

Firearms were manufactured in Springfield during the Revolutionary War. In 1794, the Springfield arsenal became the first United States Armory. In 1786, Daniel Shays led other discontented settlers in an attempt to capture the arsenal. The attempt was unsuccessful, and Shays' Rebellion was halted. See SHAYS' REBELLION.

Samuel Bowles founded the *Springfield Republican* in 1824. The paper's excellent style and liberal editorials made it nationally famous. Abolitionist John Brown lived in Springfield from 1846 until 1849, and helped organize the Underground Railroad. The first successful gasoline-powered automobile in the United States made its trial run in Springfield in 1893. Charles E. and J. Frank Duryea built it. See DURYEA (brothers).

Springfield received its city charter in 1852. The seat of Hampden County, it has a mayor-council type of government. WILLIAM J. REID

SPRINGFIELD, Mo. (pop. 120,096; met. area 168,053), is the commercial center for a large farming, lumbering, and mining district. It is the third largest city in Missouri. Springfield lies at the edge of the Ozark Mountains in southwestern Missouri, about 175 miles (282 kilometers) southeast of Kansas City and 220 miles (354 kilometers) southwest of St. Louis (see MISSOURI [political map]). It is the gateway to the scenic White River region.

Fruit grows in the large orchards nearby. The city has one of the largest dairy processing plants in the United States and is an important poultry market. It also has flour mills, meat-packing plants, electronics equipment plants, machine shops, and trailer factories. The two main lines of the Frisco Railroad intersect in the city, and have large shops there.

Springfield was settled about 1830. It became a town in 1838, and a city in 1847. Colleges in Springfield include Drury College, Evangel College, and Southwest Missouri State University. Lester Cox Medical Center, St. John's Hospital, and the Medical Center for Federal Prisoners are also in the city. Springfield has a council-manager government. The city is the seat of Greene County. NOEL P. GIST

SPRINGFIELD, Ohio (pop. 81,941; met. area 187,606), is a manufacturing city in west-central Ohio. It lies at the meeting place of Buck, or Lagonda, Creek and the Mad River, about 25 miles (40 kilometers) northeast of Dayton (see OHIO [political map]). Springfield is on the old National Road, now U.S. Route 40, which extends from Atlantic City, N.J., to San Francisco. The city was named for the springs in nearby cliffs.

Industry in Springfield is highly diversified. Factories in the city produce aircraft-engineering products, awn-

ings, chemicals, diesel engines, electric fans, hoists, incubators, lawnmowers, and lawn sweepers. Other products made in Springfield include leather goods, machine tools, metal caskets, paper-pulp machinery, piano plates, pumps, rigs for drilling wells, roadbuilding machinery, thermometers, trucks, and wire products. These industries have replaced the agricultural-implement plants that made Springfield a world center of farm-machinery production during the late 1800's.

Springfield is the home of Wittenberg University, founded in 1845. It also has a symphony orchestra and an art center. Two railroads provide freight service, and several airlines operate from the municipal airport.

The first settler of the Springfield area was James Demint, who arrived from Kentucky in 1799. Springfield became the seat of Clark County in 1818, and received its city charter in 1850. The city has a commission form of government. JAMES H. RODABAUGH

SPRINGFIELD COLLEGE. See UNIVERSITIES AND COLLEGES (table).

SPRINGS (pop. 99,047; met. area 104,090) is a gold-mining and manufacturing center in the Witwatersrand area of northern South Africa (see SOUTH AFRICA [map]). The city also is a farm-marketing center. Ten gold mines are within the city limits. Other gold and coal mines lie nearby. Springs has uranium- and food-processing plants, and factories that make machinery, electrical products, and glass. LEONARD M. THOMPSON

SPRINGTAIL. See COLLEMBOLA.

SPRINKLER SYSTEM. See FIRE FIGHTING (Turning in the Alarm); BISMUTH; ALLOY.

SPROUTING. See GERMINATION.

SPRUANCE, RAYMOND AMES (1886-1969), was one of the most successful American naval commanders in the Pacific in World War II. Naval forces under his leadership caused greater damage to the Japanese with less loss to themselves than did any other American fleet units in the war.

Many have rated Spruance as the best American naval combat commander of the war. He earned a large share of the credit for working out the circular battle formation which made U.S. carrier groups the most effective fighting fleets in naval history. He won praise for his calmness and deliberation in action.

At Midway. Shortly before the United States entered World War II, Spruance took command of a cruiser division of the Pacific Fleet. It was part of the force sent out in June, 1942, to stop a Japanese attempt to invade Midway Island. Shortly after the battle began, the force commander's flagship, the *Yorktown*, was put out of action, and Spruance took charge of the battle operations. The victory at Midway, which many historians consider the turning point of the Pacific war, established Spruance's reputation as a combat commander (see WORLD WAR II [The Battle of Midway]). Admiral Chester W. Nimitz, the Pacific Fleet's commander in chief, made him his chief of staff. In this position, Spruance planned many campaigns.

In the fall of 1943, Spruance returned to sea in charge of the assault on Tarawa in the Gilbert Islands. Three months later, as commander of the Central Pacific Force, he directed the successful attacks against the Marshall Islands. In February, 1944, he directed an aerial attack on the great Japanese naval base at Truk in what he called "a partial settlement" for Pearl Harbor. Later that year, he won an overwhelming victory in the Battle of the Philippine Sea and commanded the naval forces in the capture of Saipan and Guam.

Other Service. In February, 1945, Spruance led the Fifth Fleet in the first carrier strike on Tokyo and directed the capture of Iwo Jima. He was planning the naval phase of American landings in Japan when World War II ended. After the war, Spruance served for a time as commander in chief of the Pacific Fleet. He later became president of the Naval War College.

Spruance was born in Baltimore, Md., and was graduated from the United States Naval Academy in 1907. By 1914 he had become a recognized expert on the complicated mechanisms of warships. He served as electrical superintendent at the New York Navy Yard during most of World War I. Spruance retired from the Navy in 1948. DONALD W. MITCHELL

SPRUCE is the common name of a genus of cone-bearing evergreen trees in the pine family. About 40 kinds of spruce trees are native to the Northern Hemisphere. Some spruces grow beyond the Arctic Circle. Others grow as far south as the Pyrenees Mountains in Europe. In North America, they grow as far south as North Carolina and Arizona.

Spruces are more closely related to the firs than to any other cone-bearing tree. But spruces have cones that hang straight downward. Fir trees have cones that stand straight up. The scales on spruce cones remain on the cones. The scales on fir cones fall off when the cones become ripe.

Spruce foliage is also different from that of other cone bearers. Most spruce tree needles are four-sided and less than 1 inch (2.5 centimeters) long. Woody, peg-like projections join the needles to the twig. Fir trees do not have these projections. Spruce trees grow tall. Most are shaped like pyramids. In old trees, the drooping lower branches may brush the ground.

Kinds. The *white*, *black*, and *red* spruces of the East and the *Sitka* and *Engelmann* spruces of the West are the most important commercial spruces in North America. The white and black spruces are named for the general color of the bark and foliage. These spruces are more widely distributed than any other. They grow between Bering Strait on the north, and Maine, New York, and Michigan on the south. The black spruce also grows in high altitudes in Virginia. The trees grow west to British Columbia and Montana.

The white spruce may reach a height of 150 feet (46 meters). The black is a little smaller. The red spruce grows between Nova Scotia and North Carolina, and as far west as Tennessee. The Sitka spruce grows on the Pacific Coast from northern California to Alaska. It sometimes reaches a great height, especially in the swamps or tidewater regions. A number of giant Sitkas are over 300 feet (91 meters) high. The Engelmann spruce grows from British Columbia to New Mexico.

The most important spruce in Europe is the *Norway* spruce. This handsome tree is planted in eastern North America as an ornamental. The so-called *Douglas spruce* (Douglas fir) of Washington, Oregon, and British Columbia, belongs to a different genus, but is related to the spruces. It produces more lumber than any other tree in the world.

Devereux Butcher

The Cones of spruces like the red spruce, *above*, are *pendant* (hang downward). The needles of spruce trees grow in thick spirals around the branches and point in all directions.

J. Horace McFarland

The Silvery-Blue Foliage of the Blue Spruce makes it one of the most admired of all the American evergreen trees.

Uses. Spruce wood is widely used for wood pulp in the papermaking industry. The timber is strong, light, and flexible, and is well suited for masts and spars of ships. Spruce is also used to make boxes, and forms sounding boards for musical instruments such as pianos.

Spruce wood is also used for interior finishing in houses. Resin, tannin, and turpentine are products of spruce bark. Beer is sometimes made from young twigs. The gum of the black spruce, which is hardened resin, is another product. Dyes have been made from turpentine, which is derived as a by-product in papermaking.

Scientific Classification. Spruces belong to the pine family, *Pinaceae*. They form the genus *Picea*. The white spruce is species *P. glauca;* the black, *P. mariana;* the red, *P. rubens*. The Douglas spruce, or fir, is genus *Pseudotsuga*, species *P. menziesii*. K. A. Armson

See also Cone-Bearing Trees; Leaf (picture: Kinds of Tree Leaves); Tree (Familiar Broadleaf and Needleleaf Trees [picture]).

SPRUCE PARTRIDGE. See Grouse.

SPUR. See Horse (Spurs).

SPURGE FAMILY, or Euphorbiaceae, *yoo FAWR-bih AY see ee*, is a family of herbs, shrubs, and trees. Many of the plants give us useful products such as castor oil, croton oil, cassava, and rubber. There are about 7,300 different *species* (kinds) in the spurge family. They grow in many regions, especially in the tropics.

Members of the spurge family bear small, inconspicuous flowers, but they sometimes have brilliantly colored flower *bracts* (leaves that look like flower petals). A biting, milky juice is usually found in the plants. Some species in Africa look almost exactly like a cactus when they are not in bloom. The family also includes ornamentals such as the poinsettia. Earl L. Core

Related Articles in World Book include:

Cassava	Croton	Poinsettia	Snow-on-the-Mountain
Castor Oil	Jumping Bean	Rubber	

SPURGEON, CHARLES HADDON (1834-1892), was one of the greatest British preachers of his time. He joined the Baptist Church in 1850, and began preaching near Cambridge. He moved to London in 1854. His clear voice, rich command of language, and dramatic abilities attracted crowds. But his strict and narrow religious ideas alienated others. The Metropolitan Tabernacle, with 6,000 seats, was built for his huge audiences. He was born at Kelvedon, Essex, the son of an Independent preacher. F. A. Norwood

SPUTNIK, *SPUHT nihk*, is the Russian name of the earth satellites launched into space by Russia. *Sputnik* is a Russian word meaning *traveler*. Sputnik I, launched Oct. 4, 1957, circled the earth once about every 95 minutes at a speed of 18,000 mph (29,000 kph), until it fell to earth on Jan. 4, 1958. Later, Russia launched much larger sputniks. See also Space Travel.

SPY is anyone who abandons the uniform or distinctive badge of his service and mingles with the enemy in order to obtain information of value to the country he is serving. The international rules of war provide that a soldier in uniform cannot be considered a spy, even if he is attempting to obtain information within enemy lines. Civilians openly carrying messages through enemy lines are not considered spies if they do not attempt to disguise their identity. To be condemned as a spy, a person must be captured within enemy lines *in disguise*, or while representing to be other than what he really is. Suspected spies must receive a trial. The punishment for wartime spying usually is death. Karl Detzer

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Chambers, Whittaker	Hale, Nathan	

SPYRI, JOHANNA

SPYRI, *SHPEE ree*, **JOHANNA** (1827-1901), was a Swiss author of children's stories. Her best-known book is *Heidi* (1881), a story of child life in the Swiss Alps. *Heidi's* success encouraged Mrs. Spyri to write more books for and about children. She used the background of her childhood in Switzerland for these books. Her other books include *Cornelli* (1890) and *Vinzi* (1894). She was born in Hirzel, near Zurich. JEAN THOMSON

SQUAB. See PIGEON.

SQUAD. See ARMY, UNITED STATES (table: Army Levels of Command).

SQUALL, *skwawl*, is a sudden rise in the wind, often with a marked change in wind direction. Rain and hail may accompany the wind. A squall may be caused by an advancing mass of cold air that violently lifts the warm air in front of it.

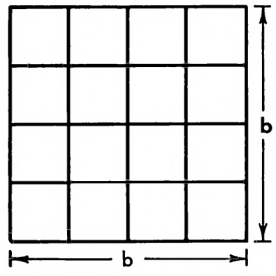
See also WEATHER (map: How to Read a Weather Map).

SQUANTO (? -1622), also called TISQUANTUM, was an American Indian of the Pawtuxet tribe and a friend of the Pilgrims. He was taken to England in 1605. He lived in London until 1614, when he was returned to America. Later, Squanto was kidnaped and sold in Spain as a slave, but he escaped to England. In 1619, an English sea captain returned him to Cape Cod.

Squanto met the Pilgrims in 1621. He acted as their interpreter in the conclusion of the treaty of Plymouth with Massasoit (see MASSASOIT). He stayed with the Pilgrims and showed them how to plant corn and where to fish. Squanto died from a fever while guiding an expedition around Cape Cod. Plymouth Colony might have failed, if not for Squanto's help. WILLIAM H. GILBERT

See also PLYMOUTH COLONY (The First Year).

SQUARE, in geometry, is a plane figure that has four equal straight sides and four right (90°) angles. If each side of a square is 4 inches long, the square can be cut into 4 × 4, or 16, smaller squares that have sides 1 inch long. The *area* of this square equals 16 square inches. In general, the area of a square is expressed in square units. It is found by multiplying by itself the number that represents the length of one side of the square. A square with a side 3 centimeters long has an area of 3 × 3, or 9, square centimeters.



In arithmetic and algebra, the *square* of a quantity is the product of a quantity by itself. For example, 16 is the square of 4, because 4 × 4 = 16. If b represents any quantity, the square of b, or $b \times b$, is written b^2. The small 2 that appears to the right of and above the b is called an *exponent*. The exponent 2 indicates that the quantity b is to be taken twice as a factor.

The term *square* also refers to a tool or instrument for measuring and constructing right angles. Carpenters often use a square made in the shape of an L and draftsmen use a square in the shape of a T. HOWARD W. EVES

See also POWER; QUADRILATERAL; SQUARE ROOT.

SQUARE DANCE is an American form of folk dance done by four couples in a square formation. They perform a variety of patterns as directed by a *caller*. Many basic *calls*, such as "promenade," "form a star," "grand right and left," "swing your partner," and "ladies chain," are common throughout the country. There are also regional differences. The call "do-si-do" means one pattern in the East and a different figure in the West.

The caller is the most important figure at a square dance. The success of the dance depends on his skill in combining the calls into interesting patterns. He often makes up rhymes on the spur of the moment as he calls, such as "swing her high, swing her low, don't step on that pretty little toe." MICHAEL HERMAN

WORLD BOOK photo

Square Dancing is perhaps the most popular form of American folk dancing. The dancers divide themselves into groups of four couples. Then they swing about, bow, join hands, and change partners in this lively type of group dancing.

SQUARE DEAL originally referred to fair treatment in dealing playing cards and in handling other transactions. President Theodore Roosevelt used the slogan repeatedly. "When I say 'square deal,' " he wrote, "I mean a square deal to everyone . . ." He declared that he would use his powers as President to safeguard the rights of both capital and labor (see ROOSEVELT, THEODORE [Friend of Labor]).

SQUARE MEASURE is the system used in the measurement of surfaces. The unit for the *area* of a surface is the square. Hence the name of the system. We can describe a table top as being 12 inches long and 10 inches wide, or 12 by 10 inches. But these figures represent only lines, which have just one dimension—that of length.

A plane surface has two dimensions—length and width. They must somehow be combined into a single expression in order to tell how much the table will hold. Thus we describe the area of the same table top as 120 square inches.

Square measure of any square or rectangular plane surface is obtained by multiplying length by width. The reason for this is easily seen if we draw a picture of the table top and mark off its inches. A line should be drawn at every inch along the length and at every inch along the width. The two sets of lines will cross each other. This will give us 120 little squares, each measuring one inch in length and one inch in width. The measure of each is called a square inch. The areas in square inches, centimeters, feet, meters, and so on, of other geometrical figures are found by special rules. These rules are all based on the one stated above. E. G. STRAUS

See also WEIGHTS AND MEASURES (Surface or Area).

SQUARE ROOT of a number is a second number whose product with itself gives the original number. For example, a square root of 4 is 2, because $2\times2=4$. The symbol for a square root, called a *radical sign*, is $\sqrt{\ }$. For example, $\sqrt{25}=5$ and $\sqrt{4}=2$. The negative number -2 is also a square root of 4, because $-2\times-2=4$. Each positive number has both a positive and negative square root. These two square roots always have the same numerical value.

Finding Square Roots

By Tables and Slide Rule. An easy method for finding a square root of a number is to use a *table of square roots*, a *table of squares*, or a *table of logarithms*. If available, these tables give a square root quickly and make long and tiresome calculations unnecessary. You can usually learn to use these tables in a short time. An even quicker way of finding a square root consists of using a *slide rule*. But a slide rule can usually give a square root in only three digits. See LOGARITHMS; SLIDE RULE.

By Dividing and Averaging. If you lack tables, or need greater accuracy than the tables can offer, you must actually compute a square root. You can easily learn, apply, and understand the following method.

Suppose you want to find the square root of 40. Because $6\times6=36$ and $7\times7=49$, you can see that 6 is closest to $\sqrt{40}$ in whole numbers. So you begin the square root of 40 with 6. First, divide 40 by 6: $40\div6=6.6$ (to the nearest tenth). You can see that $6\times6.6=39.6$, or about 40. Now find the average of 6 and 6.6: $\frac{1}{2}\times(6+6.6)=6.3$. And $6.3\times6.3=39.69$, which is even closer to 40.

To obtain greater accuracy, repeat the procedure. First, divide 40 by 6.3: $40\div6.3=6.349$. Next, find the average of 6.3 and 6.349: $\frac{1}{2}\times(6.3+6.349)=6.325$. Repeating the procedure a third time, you find that $40\div6.325=6.3241106$, and that $\frac{1}{2}\times(6.325+6.3241106)=6.3245553$.

You may continue this process as long as you wish. In general, in each approximation to the square root you usually keep twice as many digits as in the previous approximation.

Notice that 40 lies between 1 and 100. If you want to find the square root of a number that is not in the 1 to 100 range, you must first divide or multiply it by 100 to bring it within this range. Suppose you want to find the square root of 400,000, or $\sqrt{400{,}000}$. You must divide 400,000 *twice* by 100. This gives you 40, a number within the 1 to 100 range. You know how to find the square root of 40: $\sqrt{40}=6.3245553$. Now you must multiply the square root of 40 *twice* by 10 (the square root of 100) to obtain the square root of 400,000: $6.3245553\times10\times10=632.45553$. In the same way, $\sqrt{0.4}=0.63245553$. You find the square root of 0.4 by multiplying by 100, finding the square root of 40, and dividing by 10.

A Method Often Used in School

Besides the above, you can use other processes for finding square roots. Here is a method often taught in schools.

Find $\sqrt{1248.4}$

Step 1. Using little marks, separate 1,248.4 into two-digit *periods*, or units, in each direction from the decimal point. One digit of the square root will correspond to each two-digit period.

$$\sqrt{12'48.40'}$$

Now determine the largest *square*, or number multiplied once by itself, in 12, the leading two-digit period. The largest square in 12 is 3×3, or 9. Write 3 as the first digit of the square root, subtract 9 from 12, and bring down the next period to form the remainder 348:

$$\begin{array}{r} 3 \\ \sqrt{12'48.40'} \\ 9 \\ \hline 3\ 48 \end{array}$$

Step 2. Multiply the partial square root, 3, by 2, and place the product, 6, to the left of 348. Determine the next digit of the square root by dividing 348 by 10×6, or 60: $348\div60=5$. Write 5 as the next digit of the square root and annex 5 to the 6 to form the divisor 65. Now multiply 65 by 5, subtract the product from 348, and bring down the next period to form the remainder 2,340:

$$\begin{array}{rr} & 3\ 5 \\ & \sqrt{12'48.40'} \\ & 9 \\ 65 & \vert\ 3\ 48 \\ & \vert\ 3\ 25 \\ \hline & 23\ 40 \end{array}$$

Step 3. Multiply the partial square root, 35, by 2, and place the product, 70, to the left of 2,340. Determine the third digit of the square root by dividing 2,340 by 10×70, or 700: 2,340÷700=3. Write 3 as the third digit of the square root and annex 3 to the 70 to form the divisor 703. Multiply 703 by 3, subtract the product from 2,340, and bring down the next period to form the remainder 23,100:

```
        3  5. 3
    √12'48.40'
       9
     ------
65   | 3 48
     | 3 25
     ------
703    |23 40
       |21 09
       -------
         2 31 00
```

You may continue this process as long as you wish. Place the decimal point in the square root over the decimal point in the given number.

Square Roots of Negative Numbers

What is the square root of −4? Or, what number multiplied by itself gives a product of −4? If there is such a number, it certainly cannot be positive, negative, or zero. None of these multiplied by itself can give a negative number. But, for convenience in solving certain problems, mathematicians have invented a system of *pure imaginary numbers* whose squares are negative numbers. HOWARD W. EVES

See also CUBE ROOT; ROOT; SQUARE.

SQUASH is the name given to three groups of vine vegetables. All three are warm-weather crops, but their growth periods vary. One group includes summer squash and orange-colored winter pumpkins. The second group includes straw-colored *cheese pumpkins* and *cushaw* squashes. The third group includes squashes which can be stored over winter.

Summer squashes grow rapidly. The fruits are harvested while still immature. The autumn squashes produce small fruits. They are harvested when almost mature. The autumn squashes can be stored for a few months, but they rapidly lose their quality. The winter squashes are harvested as soon as they mature. They have hard shells and may be stored through the winter. The Hubbard squash is perhaps the best-known winter variety. Each of these groups has several types and varieties.

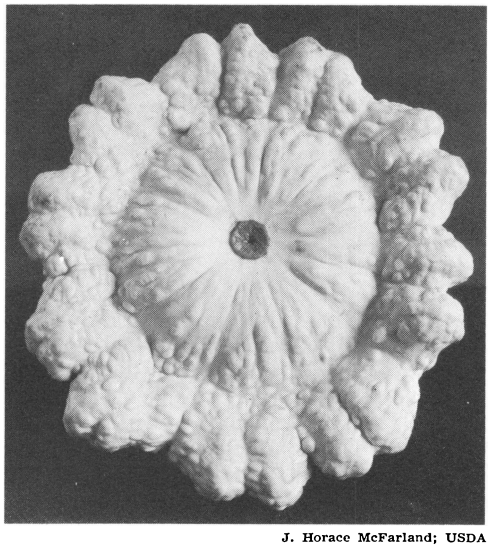
Seeds are planted in *hills* (groups of about three plants) about two weeks before the last frost of spring. Several insects attack squashes. Squash bugs are hard to control. The adults, called *stink bugs*, may be picked by hand and killed, or dusted with insecticides such as nicotine, rotenone, or chlordane. The squashvine borer may be controlled by cutting the stem where the insect enters the squash, and covering the stem with soil.

Squashes provide a good source of vitamin A. They also have a fair degree of energy value.

The history of squashes and pumpkins runs together. Both were first raised in North, Central, and South America. After the Americas were discovered, squash were taken to France and England. Summer squashes thrive in England, where they are called *marrows*. But fall and winter squashes do not grow well in England.

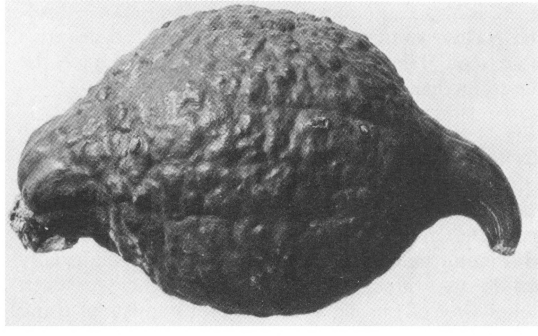
Scientific Classification. Squashes and pumpkins belong to the gourd family, *Cucurbitaceae*. Pumpkins are genus *Cucurbita*, species *C. pepo*. Summer squashes are *C. pepo*, variety *melopepo*. Winter squashes are *C. maxima;* cheese pumpkins, *C. moschata*. ERVIN L. DENISEN

See also CHAYOTE; GOURD; PUMPKIN.

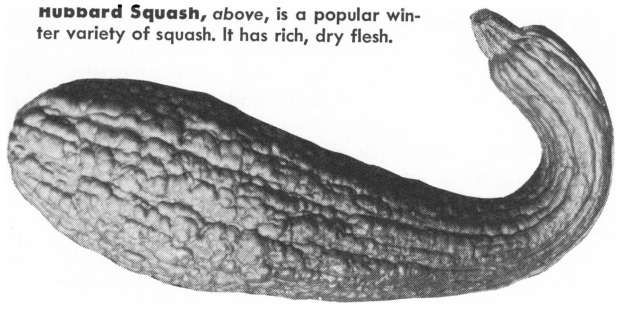


J. Horace McFarland; USDA

White Bush Scallop, *above,* is a summer squash. Because of its shape, it is sometimes called a "pattypan."



Hubbard Squash, *above,* is a popular winter variety of squash. It has rich, dry flesh.



The Giant Yellow Crookneck, *right,* has a warty yellow skin and fine-textured, cream-colored flesh.

SQUASH is an indoor game similar to handball. But squash is played with rackets and a hard rubber ball about the size of a golf ball. Players use the rackets to hit the ball against the four walls of a court. A player may hit the ball against any wall so long as it reaches the front wall before it touches the floor. His opponent must then hit the ball before it bounces twice. A variety of shots is possible, and the ball travels quickly.

Singles squash is played by two men in a cement or wood court 32 feet (10 meters) long and 18½ feet (5.6 meters) wide. The front and side walls are 16 feet (4.9 meters) high, and the back wall is 6½ feet (2 meters) high. *Doubles* squash is played by four men on a larger court. At the bottom of the front wall is a *telltale* (17 inches (43 centimeters) high, made of metal. If a player hits the telltale with the ball, his opponent wins the point. The opponent also wins the point when the player misses the ball, hits it after the second bounce, or hits it out of the court. The game ends when a player or team has scored 15 points.

Squash originated at Harrow School in England about 1850, and was introduced into the United States from Canada in the 1880's. The United States has about 1,500 squash courts and 50,000 players. The sport, particularly popular in Australia, is also played in about 30 other nations. THOMAS H. LINEAWEAVER, III

SQUATTER is a person who lives on land to which he has no deed or other evidence of title. Usually he may make a valid claim to the land if there is no other person with a legal claim. During the period of the westward movement in the United States, many people moved to lands which had not yet been surveyed and which were not yet for sale. Congress passed special laws which allowed squatters to gain title to the lands they occupied. These laws culminated in the Pre-emption Act of 1841 (see PRE-EMPTION).

SQUATTER SOVEREIGNTY

From 1854 to 1861, the term *squatter* in American politics had a special meaning in connection with *squatter*, or popular, sovereignty (see SQUATTER SOVEREIGNTY). HAROLD W. BRADLEY

See also HOMESTEAD ACT; SQUATTER'S RIGHTS.

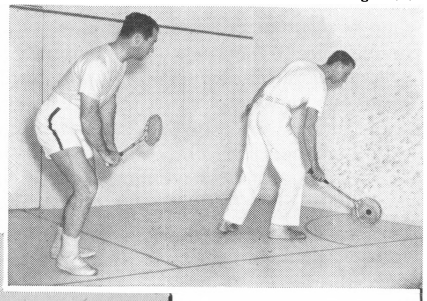
SQUATTER SOVEREIGNTY, or POPULAR SOVEREIGNTY, was the doctrine that the people of a territory could decide for themselves whether or not they wanted slavery, even before the territory became a state. This theory developed during the controversy over slavery that is part of the history of the early United States.

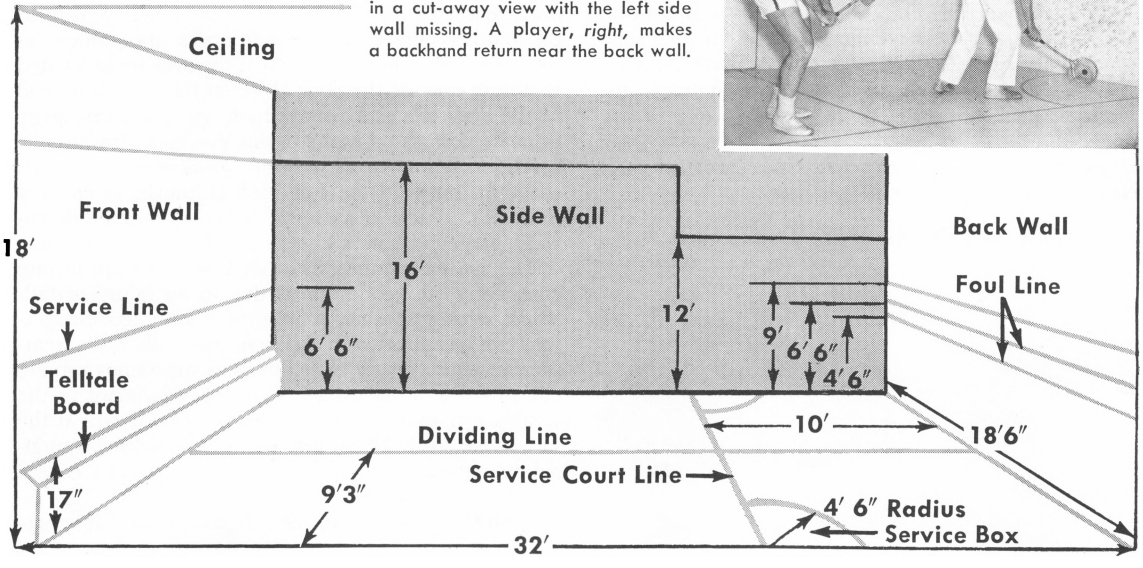
The North, as a whole, opposed extension of slavery into any of the land acquired from Mexico after the war with Mexico. The South, even more unanimously, favored it. Many persons on both sides found the theory of squatter sovereignty a happy solution. It relieved both the states and the Congress of a difficult problem. Lewis Cass probably originated the theory of squatter sovereignty, but Stephen A. Douglas was its most prominent advocate. Douglas renamed it *popular sovereignty.*

The Kansas-Nebraska Act of 1854 permitted the people of the Kansas and Nebraska territories to decide for or against slavery within their respective borders. The authors of the law took for granted that Nebraska would vote free, and Kansas, slave. But antislavery advocates sent many free-state settlers into Kansas, while many proslavery residents of Missouri crossed into Kansas, sometimes to settle, but often only to vote. The violence and bloodshed that resulted showed that the principle of popular sovereignty would not work. After the Civil War, when slavery was abolished, popular sovereignty lost its significance. JOHN DONALD HICKS

See also DOUGLAS, STEPHEN ARNOLD; KANSAS-NEBRASKA ACT.

Union League Club





SQUATTER'S RIGHTS. During the westward movement in the United States, many *squatters* settled on unsurveyed public land with no title. They did so to avoid buying land or because there was not enough surveyed land to meet the demand. They generally built homes and cleared the land. They believed they had thus earned the right to buy the land at the minimum price when the government sold it. This claim is known as *squatter's rights*. Squatters formed *claim associations* to protect their land before public sales were held. Most Westerners supported the squatters, and Western congressmen backed bills to protect their interests. The Pre-emption Act of 1841 recognized squatter's rights. See also PRE-EMPTION; SQUATTER. HAROLD W. BRADLEY

SQUETEAGUE. See WEAKFISH.

SQUIB. See NEWSPAPER (Newspaper Terms).

SQUID is a sea *mollusk* (animal with a soft, boneless body) that is similar to the octopus, nautilus, and cuttlefish. Squids live throughout the world. They frequently swim in large groups called *shoals*. These animals are also called SEA ARROWS.

Squids have dark gray bodies with red spots. The body has two fins at the tail end. The head is surrounded by 10 arms, two of which are longer than the others. Each arm has rows of round sucking discs which it uses to catch and hold its prey. The animal has a horny *pen* (shell) inside its body. Squids range in size from less than 1 foot (30 centimeters) to nearly 40 feet (12 meters) in length, including the arms. The giant squid may measure 55 feet (17 meters) long.

The squid's head has two well-developed eyes, a pair of powerful jaws, and a rough *radula* (tongue). A muscular tube, or funnel, lies beneath the head. The squid swims by filling the folds in its body walls with water and forcing it through the tube. This "jet" action makes the animal move. An "ink sac" spurts a dark fluid when a squid flees from an enemy. Squids can also change color to blend with the environment.

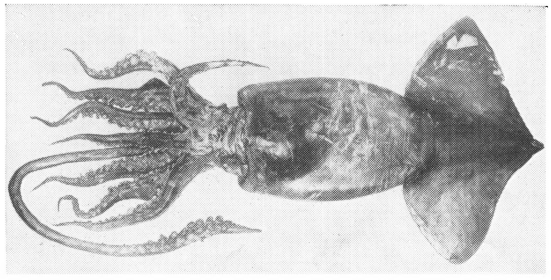
Some people eat squid. Fishermen use them for bait. Squids are serious pests to the mackerel and herring fishing industry because they eat large numbers of these and other small fish. The common squid is found from Nova Scotia to Florida. Giant squids swim in Pacific waters near New Zealand and in the North Atlantic.

Scientific Classification. The common squid belongs to the squid family, *Loliginidae*. It is genus *Loligo*, species *L. pealeii*. R. TUCKER ABBOTT

See also ARGONAUT; CUTTLEFISH; MOLLUSK (picture); NAUTILUS; OCTOPUS; OCEAN (pictures).

The Ten Arms of the Squid Are Used to Catch Fish.

American Museum of Natural History



USDA

The Big Bulblike Root of Squill Is Used in Medicine.

SQUILL is the name of several plants with bulbous roots. They belong to the lily family. One kind of squill, called the *sea onion*, grows around the Mediterranean Sea. It produces bulbs that sometimes weigh as much as 4 pounds (1.8 kilograms). The bulbs of this squill have medicinal value.

Gardeners collect the bulbs of the sea onion in August. They remove the outer husk, slice the bulb, and dry it in the sun. People make a drug from the bulbs. Usually they use it in syrup form or in "tincture of squill." It stimulates the heart and is rather irritating. It particularly affects the stomach, intestines, and bronchial tracts. Sometimes doctors use squill as an expectorant and diuretic. They also treat chronic bronchitis with it, but never when the disease is acute. Red squill is used as a rat poison.

Squill is also the name given the genus *Scilla* in the lily family. It includes 80 or more species that are found in the temperate regions of Europe.

Scientific Classification. The sea onion belongs to the lily family, *Liliaceae*. It is classified as genus *Urginea*, species *U. maritima*. HAROLD NORMAN MOLDENKE

SQUINT is an abnormal condition of the eyes in which one eye is fixed on one object, and the other eye is fixed on another object. This condition is also known as *strabismus* and *cross-eye*. Normally, the eyes are so located that both eyes see the same object at the same time and in the same place. In strabismus, one eye turns away from its normal position. If this eye turns inward the condition is known as *convergent strabismus*, and if the eye turns outward the condition is known as *divergent strabismus*. If the crossed eye turns upward or downward, the condition is known as *supravergent strabismus*.

The cause of strabismus is not known, except in rare cases where the condition is due to an injury or fall. The tendency to have strabismus is inherited. Strabismus can be corrected in children, especially if the treatment is started early. Treatment of strabismus usually consists of wearing glasses, forced development of the weaker eye, and training in the use of both eyes at the same time. Only 15 per cent of all cases require a surgical operation. HARRY S. GRADLE

See also CROSS-EYE.

SQUIRE, or **ESQUIRE.** See KNIGHTS AND KNIGHTHOOD.

Ed. Cesar, N.A.S.

Douglas Squirrel and Young

Alvin E. Staffan, N.A.S.

Eastern Gray Squirrel

SQUIRREL is a furry-tailed animal with large, black eyes and rounded ears. Many squirrels are lively animals with long, bushy tails. They scamper about the ground or in trees, and leap from branch to branch. These *tree squirrels* are often seen in parks and woodlands. They include gray squirrels, red squirrels, and flying squirrels. But many kinds of squirrels have short tails and never climb trees. They are called *ground squirrels*, and include chipmunks, marmots, prairie dogs, and woodchucks.

Squirrels live throughout the world except in Australia, Madagascar, and southern South America. One of the smallest squirrels is the African pygmy squirrel, found in western Africa. It weighs about $\frac{1}{2}$ ounce (14 grams) and is 3 inches (8 centimeters) long without the 2-inch (5-centimeter) tail. The marmot is the largest squirrel. It weighs up to 20 pounds (9 kilograms) and grows as long as 30 inches (76 centimeters), including a 10-inch (25-centimeter) tail.

There are more than 300 kinds of squirrels, and they make up the squirrel family, *Sciuridae*. Squirrels are one of the largest families of *rodents* (gnawing animals). Like other rodents, all squirrels have chisel-like front teeth.

Daniel Brant, the contributor of this article, is Professor of Biology at Humboldt State University.

Many kinds of squirrels, especially tree squirrels and chipmunks, are easy to tame. They may learn to take nuts and other food from a person's hand. But many squirrels, like most other furry animals, carry the germs of a disease called *rabies*. Even a tame squirrel may bite or scratch a person and give him rabies.

The word *squirrel* comes from two Greek words that mean *shadow tail*. At first, the word may have been used only for tree squirrels. The large, bushy tails of these animals curl over their backs and seem to keep them in the shade.

The rest of this article is about tree squirrels only. To learn more about the various kinds of ground squirrels, see the WORLD BOOK articles on CHIPMUNK; MARMOT; PRAIRIE DOG; and WOODCHUCK.

Homes. Most kinds of tree squirrels are active, noisy animals. They seem to scold one another continually in a variety of loud chirps, whistles, and noises that sound somewhat like *chirrrr*.

FACTS IN BRIEF

Common Name	Scientific Name	Gestation Period	Number of Young	Life Span (in captivity)
Flying Squirrel	*Glaucomys*	40 days	2-6	7-13 years
Fox Squirrel	*Sciurus*	45 days	2-4	9 years
Gray Squirrel	*Sciurus*	44 days	2-5	8-15 years
Red Squirrel	*Tamiasciurus*	40 days	4	8-9 years

Squirrels make up the squirrel family, *Sciuridae*.

SQUIRREL

Many squirrels have two homes—a warm, permanent one, and a temporary one that is cool enough for hot days. The permanent home may be a den in a hollow tree trunk, or a sturdy nest built on a branch. A squirrel's den is lined with dry leaves and strips of bark. During the winter, several squirrels may share one den. A squirrel's permanent nest is made of layers of twigs and leaves packed together tightly to keep out rain, snow, and wind. A temporary nest is only a loose pile of twigs and leaves. It soon falls apart, and a squirrel may have to build several during a summer.

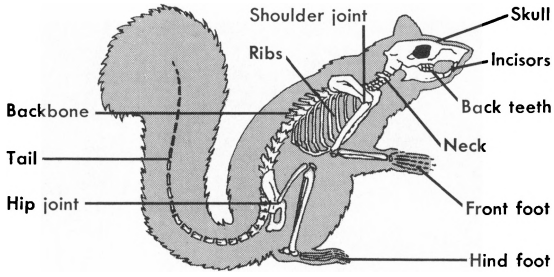
Squirrels move about easily in trees or on rooftops or telephone wires. They spread their legs straight out and leap from place to place. Squirrels use their bushy tails to keep their balance when they jump.

Food. Squirrels eat berries, corn, fruits, nuts, mushrooms, and seeds. They spend much of their time searching for food. A squirrel is especially busy in autumn, when it gathers food and hides it to eat during winter. Squirrels store food in holes in the ground, in trees, or in their dens.

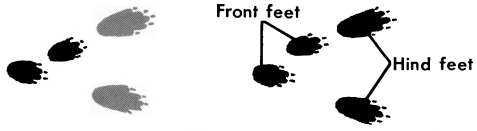
Red squirrels are famous for the many pine cones they cut and store for food. A red squirrel may cut more than a hundred cones from a tree in an hour. Then the animal rushes down to the ground, gathers the cones, and hides them. The hiding place for the cones may be a hollow tree stump. Or the squirrel may pile the cones around a stone or a log and cover them with leaves. When winter comes, the squirrel may have 3 to 10 bushels of cones.

Young. A female squirrel carries her young in her body for 36 to 45 days before birth. She may give birth twice a year, and usually from two to six young are born at a time. Newborn squirrels have no fur, and their eyes are closed. Red squirrels and flying squirrels may open their eyes 26 to 28 days after birth, but gray squirrels may take as long as 37 days. When squirrels are 5 to 8 weeks old, they have all their fur and begin to search for their own food. They start to have their own families when they are about a year old.

THE BODY OF A SQUIRREL



SQUIRREL TRACKS



WORLD BOOK illustration by Tom Dolan

Enemies. Man is the greatest enemy of squirrels. Men hunt most kinds of squirrels for sport, but they hunt tree squirrels especially for meat and fur. Other enemies of squirrels include bobcats, cats, coyotes, dogs, and foxes. Tree squirrels race for the nearest tree when an enemy comes near. Squirrels may live for 2 to 6 years in the wild. Some have lived for 15 years in captivity.

Kinds of Tree Squirrels. There are three chief groups of tree squirrels in the United States and Canada: (1) gray squirrels, (2) red squirrels, and (3) flying squirrels.

Gray Squirrels. Fox squirrels are the largest gray squirrels. Some grow 28 inches (71 centimeters) long, including a 12-inch (30-centimeter) tail. They weigh as much as 3 pounds (1.4 kilograms). Their fur is gray, reddish brown, or black. Fox squirrels are slower and tamer than most other kinds of tree squirrels. They live in the United States east of the Rocky Mountains.

Eastern gray squirrels and western gray squirrels are 16 to 24 inches (41 to 61 centimeters) long, including their tails. They weigh from $\frac{3}{4}$ to $1\frac{1}{2}$ pounds (0.3 to 0.7

Kaibab Squirrels, or tassel-eared squirrels, have tufts of fur on their ears. They live in pine forests near the Grand Canyon.

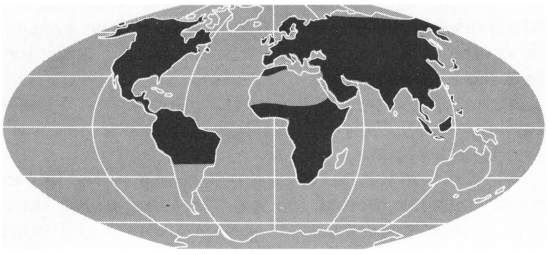
Willis Peterson

Giant Squirrel is the largest tree squirrel. It grows up to 18 inches (46 centimeters) long, with a tail of the same length.

San Diego Zoo Photo

WHERE SQUIRRELS LIVE

The black areas on this map show where squirrels are found.



kilogram). Most gray squirrels have gray fur on their backs, and whitish fur on their underparts. Eastern gray squirrels live east of the Rocky Mountains, and western gray squirrels live along the Pacific Coast.

Red Squirrels are the noisiest and most active of all the squirrels. They always seem to be busy cutting down pine cones and hiding them, scolding one another while they work. Few red squirrels are over 12 inches (30 centimeters) long, including the tail. They weigh 5 to 11 ounces (140 to 312 grams). These squirrels have reddish fur on their backs. Some have a line of dark fur that separates the red fur from the white fur on the underparts. The Kaibab squirrel has a white tail and long hairs on its ears. It lives in the pine forests north of the Grand Canyon, but is rarely seen. Red squirrels are found in most parts of the United States and Canada except in the Great Plains.

Flying Squirrels are the smallest kind of tree squirrels. Few grow more than 10 inches (25 centimeters) long, including the tail. The flying squirrel has a fold of skin that stretches from its front leg to its rear leg on each side of its body. This skin acts like the wings of a glider, and gives the animal "lift." Some flying squirrels can glide more than 150 feet (46 meters), but 50 to 60 feet (15 to 18 meters) is a more usual distance.

Unlike other kinds of tree squirrels, flying squirrels are usually active only at night. They live throughout the United States and Canada. DANIEL BRANT

See also CHIPMUNK; FLYING SQUIRREL; MARMOT; PRAIRIE DOG; WOODCHUCK.

SQUIRREL CORN. See DICENTRA.

SQUIRREL HAKE. See HAKE.

SQUIRREL MONKEY is a small, brightly colored monkey that lives in large groups. Some groups have up to 500 monkeys. Bands of squirrel monkeys live in the forests of Central and South America, from Costa Rica to Paraguay. They move swiftly through the trees and on the ground, seeking fruits and insects to eat. They use their long tails for balance when standing or leaping but do not use them for grasping. Most squirrel monkeys grow about 1 foot (30 centimeters) long and weigh less than 2 pounds (0.9 kilogram).

The squirrel monkey has an ash-gray or red-brown back, with shades of gold or olive. Bright yellow or orangish fur covers the lower parts of the limbs. The chest is white or light yellow. The black nose and mouth area contrasts with the white fur around the eyes.

Scientific Classification. Squirrel monkeys belong to the New World monkey family, *Cebidae*. They make up the genus *Saimiri*. A common species is *S. sciureus*. NEIL C. TAPPEN

SQUIRRELTAIL GRASS. See WILD BARLEY.

SRI LANKA

SRI LANKA is a beautiful island country in the Indian Ocean. It lies about 20 miles (32 kilometers) off the southeastern coast of India. Sri Lanka is about as large as the state of West Virginia, but it has more than 8 times as many people. The country's official name is the *Republic of Sri Lanka*. It was formerly called *Ceylon*.

Sri Lanka is a land of rich tropical plant life. The island has been famous for more than 2,000 years for its spices and precious stones. It ranks second only to India in tea production, and is a leading rubber producer.

Sri Lanka became independent in 1948 after nearly 450 years of European rule. Colombo, one of the world's busiest seaports, is the capital and largest city.

Government. Sri Lanka is a republic. The president serves as the head of state, but the prime minister actually governs the country. A board of ministers (cabinet) assists the prime minister. The legislature is a 157-member National State Assembly. All citizens 18 years of age or older may vote.

People. Sri Lanka has six distinct groups of people—Sinhalese, Tamils, Moors, Burghers, Malays, and Veddahs. The *Sinhalese* make up about three-fourths of the population. Their language is called Sinhala and most of them are Buddhists. They are descended from people who came from northern India. About a fifth of the population are *Tamils*, descendants of people who came from southern India. The Tamils are Hindus, and speak Tamil, a southern Indian language. Most of them live in the northern and eastern parts of the country. The Sinhalese and Tamils use the Indian *caste* system (see CASTE). The *Moors*, descendants of Arabs, also speak Tamil. Most of them are Moslems. The *Burghers* are descendants of European settlers who intermarried with the people of Sri Lanka. Most of them are

FACTS IN BRIEF

Capital: Colombo.

Form of Government: Republic.

Parliament: *National State Assembly*—157 members.

Area: 25,332 sq. mi. (65,610 km²). *Greatest Distances*—north-south, 274 mi. (441 km); east-west, 142 mi. (229 km). *Coastline*—725 mi. (1,167 km).

Highest Elevation: Pidurutalagala, 8,281 ft. (2,524 m).

Population: *Estimated 1976 Population*—14,274,000; distribution, 78 per cent rural, 22 per cent urban; density, 565 persons per sq. mi. (218 per km²). *1971 Census*—12,711,143. *Estimated 1981 Population*—15,993,000.

Chief Products: *Agriculture*—cacao, cinnamon, coconuts, cotton, pepper, rice, rubber, tea, tobacco. *Mining*—aquamarine, graphite, limestone, moonstone, ruby, sapphire, topaz, tourmaline, zircon.

Flag: The gold lion on a crimson field is a symbol of a precolonial Sri Lankan state. The ornaments in the corners of the crimson field are gold bo leaves, Buddhist symbols. Vertical green (Moslems) and orange (Tamils) stripes at the left stand for minorities. See FLAG (color picture: Flags of Asia).

Money: *Basic Unit*—rupee. For the value of the rupee in dollars, see MONEY (table: Values).

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Ewing Galloway

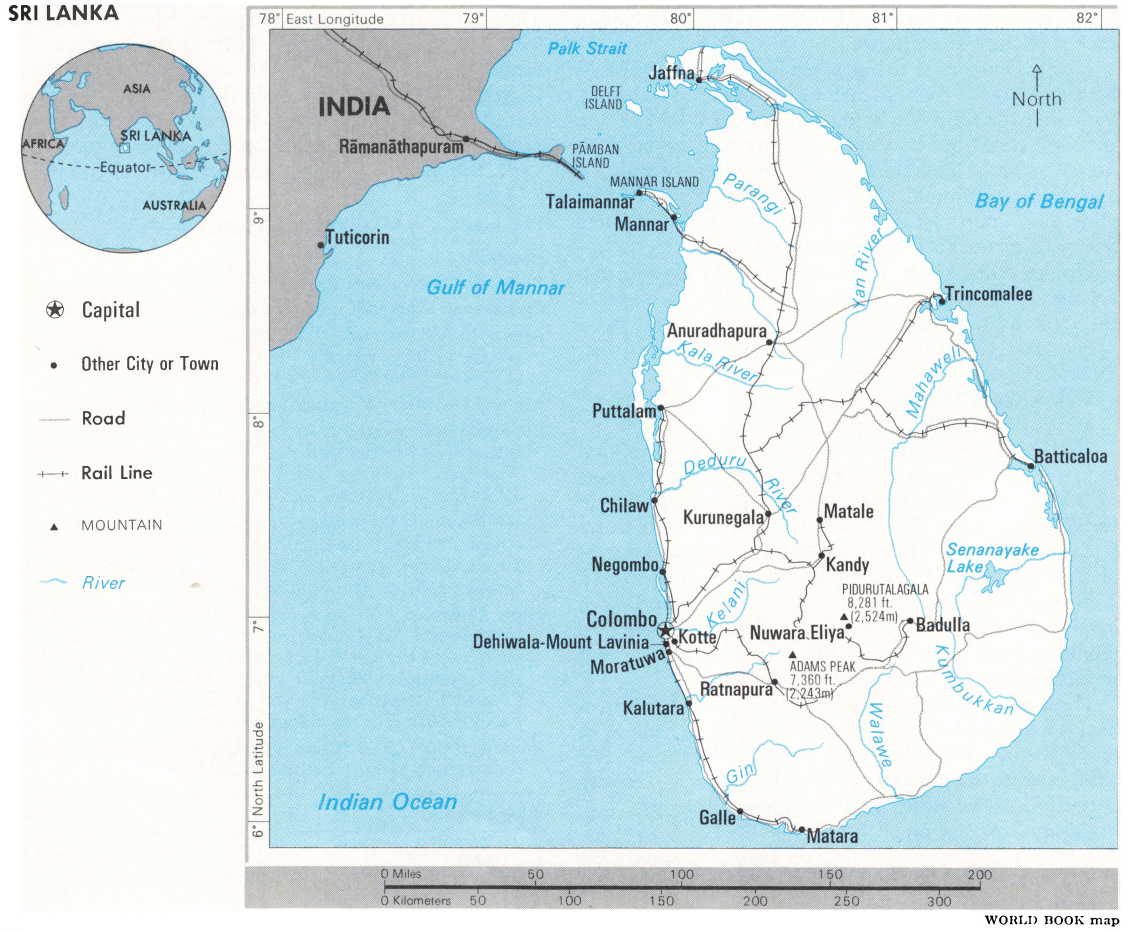
At Harvesttime in Sri Lanka, many farmers still use flails to thresh the grain. Some have begun to use machinery.

Christians and live in cities. The *Malays*, descended from people who came from what is now Malaysia, are Moslems and live mainly in the southwest. The *Veddahs*, descendants of the country's first known residents, live in remote forest regions and practice tribal religions.

Most Sri Lankans live in villages and work on farms or plantations. They live in houses that have mud walls and thatched roofs.

Most of the men of Sri Lanka wear a *sarong* (a garment wrapped around the waist to form a long skirt) and a long collarless shirt. Some men in the cities wear European-style clothing. Most women wear a *sari* (a straight piece of cloth draped around the body as a long dress) or a *camboy* (a sarong-type skirt and blouse). Rice is the chief food of the people. They usually serve it with fish, vegetable, or meat *curry* (a dish prepared in a spiced sauce).

Religious festivals and *pilgrimages* (journeys) to holy places play a major part in the life of the people. In May, Buddhists celebrate the birth, enlightenment, and death of the Buddha by lighting their houses with candles and colored lamps. Adams Peak, one of the island's highest mountains, is regarded as holy by most of the people. Buddhists visit a rock on the peak to see a footprint that they believe was made by the Buddha.



WORLD BOOK map

Many Christians and Moslems also climb to the peak because they believe that Adam lived there after he was cast out of the Garden of Eden.

About 80 per cent of the people can read and write. Education is free and compulsory for children from 6 to 14 years of age. Sri Lanka has one university, with campuses in Colombo and three other cities.

Land. The rim of the island is a low coastal plain which runs inland from the northern and eastern shores. The central and southern sections rise to mountains of over 8,000 feet (2,400 meters). Rivers flow from the mountains through the forests and tea and rubber plantations to the coast. An irrigation system supplies farmlands in the dry central lowlands area.

Sri Lanka lies near the equator, but sea breezes keep the temperature about 80° F. (27° C). *Monsoons* (seasonal winds) bring most of the rain, which varies from 40 inches (100 centimeters) a year in the north to 200 inches (510 centimeters) on the southwestern mountains.

Economy. Tea accounts for about two-thirds of the country's exports, and rubber for about a sixth. Coconut palms and rice grow well in the coastal plains. But Sri Lanka has to import large quantities of rice to meet its food requirements. Forests produce such valuable lumber as ebony and satinwood. Big rubber plantations lie in the hills, and tea grows on the mountain slopes. The country's mines produce such precious stones as sapphires and rubies, and Sri Lanka leads the world in the production of high quality graphite. See COCONUT PALM (table); RUBBER (table); TEA (table).

History. The Veddahs, a wandering people, were the first known inhabitants of Sri Lanka. Vijaya, a prince from northern India, invaded the island in about 500 B.C. and founded the Sinhalese dynasty. Later, the Tamils of southern India invaded the country and settled in the northern part. From the A.D. 1100's to the 1500's, the country had a Tamil kingdom in the north and a Sinhalese kingdom in the south.

European control of the island began in the 1500's. The Portuguese landed in Colombo in 1505, and ruled most of the island from the end of the 1500's until the Dutch took Colombo in 1656.

British forces captured the country in 1796, and made it a crown colony in 1802. The British planted the first rubber trees, and developed rubber plantations. The country gained self-government gradually during the 1900's, and became an independent dominion in the Commonwealth of Nations on Feb 4, 1948.

Trouble arose between the Tamils and Sinhalese in the late 1940's over a proposal to make Sinhala the official language. Tamils demanded that Tamil also be an official language. Tension grew after the government made Sinhala the official language in 1956. Rioting broke out in 1958, and a state of emergency was declared. Compromises later provided that Tamil be used for official purposes in many areas.

Prime Minister S.W.R.D. Bandaranaike was murdered in 1959. The following year his widow, Sirimavo Bandaranaike, became the world's first woman prime minister. Dudley Senanayake became prime minister in 1965, but Mrs. Bandaranaike defeated him in 1970. In 1971, thousands of the people, dissatisfied with government economic policies, tried to overthrow the government. Army and police forces put down the revolt. In 1972, the country adopted a new constitution and became the Republic of Sri Lanka. B. N. PANDEY

Pictorial Parade

A Moslem Mosque in Colombo towers over the shops that line this street. Colombo is Sri Lanka's capital and trading center.

See also BANDARANAIKE, SIRIMAVO; COLOMBO; TRINCOMALEE; SCULPTURE (Ceylon); ASIA (picture: Handicrafts Industry); RACES OF MAN (picture: Indian).

SRINAGAR, *sree NUG er* (pop. 403,413), is the capital of India's state of Jammu and Kashmir. The city lies about 170 miles (274 kilometers) northeast of Amritsar in the Vale of Kashmir (see INDIA [political map]). Nearby are the Shalimar Gardens, which were built by the Moguls. British and Indian residents enjoy vacations in houseboats on the nearby lakes or on the Jhelum River, which flows through Srinagar. The city's chief products include rugs, silver articles, wood carvings, paper, and leather goods. ROBERT I. CRANE

SS TROOPS. See HITLER, ADOLF (Rise of the Nazis).

SST. See AIRPLANE (Airplanes of Today; picture).

ST. ———. See SAINT ———.

STABILE. See CALDER, ALEXANDER.

STABILIZER. See GYROPILOT; GYROSCOPE; GYROSTABILIZER; AIRPLANE (The Tail Assembly).

STABLE EQUILIBRIUM. See GRAVITY, CENTER OF.

STADACONA was an Indian town where the city of Quebec now stands. See QUEBEC (Early Days).

STADHOLDER. See NETHERLANDS (Wars with England and France).

STADIUM, *STAY dee uhm,* is a large structure for spectators built around a playing field or arena.

One of the first stadiums was the foot-race course in Olympia in ancient Greece. Other famous stadiums were in Delphi, Athens, and Epidaurus in Greece and

— 25 LARGEST STADIUMS IN THE UNITED STATES —

Name and Location	Seating Capacity
Rose Bowl, Pasadena, Calif.	*101,025
University of Michigan Stadium, Ann Arbor	101,001
Soldier Field, Chicago	*99,670
John F. Kennedy Stadium, Philadelphia	99,004
Superdome, New Orleans, La.†	97,365
Memorial Coliseum, Los Angeles	93,791
Stanford (University) Stadium, Palo Alto, Calif.	90,000
Tulane (University) Stadium (Sugar Bowl), New Orleans	*81,889
Ohio (State University) Stadium, Columbus	*81,455
Orange Bowl Stadium, Miami	*80,500
Rich Stadium, Orchard Park, N.Y.	80,040
Municipal Stadium, Cleveland	79,282
Arrowhead Stadium, Kansas City, Mo.	78,138
Franklin Field, Philadelphia	*78,079
Camp Randall Stadium (University of Wisconsin), Madison	77,248
Memorial Stadium (University of California), Berkeley	*77,023
Giants Stadium, East Rutherford, N.J.†	76,500
Spartan Stadium (Michigan State University), East Lansing	76,000
Mile High Stadium, Denver, Colo.†	75,000
Gator Bowl, Jacksonville, Fla.	*74,813
Rice University Stadium, Houston	*72,500
Cotton Bowl Stadium, Dallas	72,032
Yale (University) Bowl, New Haven, Conn.	70,874
Memorial Stadium (University of Illinois), Champaign	*69,573
Legion Stadium, Birmingham, Ala.	*69,021

*Includes temporary seats. †Under construction in 1975.

in Ephesus in Asia Minor. Usually terraces shaped like horseshoes enclosed the stadiums to give the spectators a clear view of the field. Seats were often built on the terraces. The famous stadium in Athens was rebuilt and used for the Olympic Games in 1896.

Today's stadium has seats arranged in *tiers* (rows) from which spectators view football and baseball games, track meets, boxing matches, and other public events. Universities have built many stadiums for athletic games. Students and alumni have often paid for memorial stadiums. Some cities have built municipal stadiums where both civic events and sports events are held. Domed stadiums can be used for baseball, football, circuses, conventions, and other events.

The word *stadium* comes from the Greek word *stadion*, which meant the distance between the end pillars of the stadium located at Olympia (about 630 feet, or 192 meters). ELMER D. MITCHELL

See also COLOSSEUM; HIPPODROME; OLYMPIC GAMES.

STAËL, *stahl*, **MADAME DE** (1766-1817), was a prominent French critic and novelist of the early 1800's. Her literary work influenced the growth of romanticism in French literature.

Madame de Staël was one of the first to apply the notion of progress to literature. She felt literature was an extension of society and should reflect social change. In her critical works, such as *On Literature* (1800) and *On Germany* (1810), she emphasized that judgment should be relative, not absolute. *On Germany* introduced the German culture and such great thinkers as Friedrich von Schiller to Europe as a model to imitate.

Her two novels, *Delphine* (1802) and *Corinne* (1807), reflect her own life. They deal with women who disregard public opinion. Their theme, the conflict between the superior person and society, became popular in the romantic movement.

Madame de Staël was born Anne Louise Germaine Necker in Paris. She married Baron Staël-Holstein, Swedish ambassador to France, in 1786, but the marriage ended unhappily. She had a famous love affair with novelist Benjamin Constant. In 1811 she married Albert de Rocca, a Swiss military officer. She traveled extensively in Germany, Italy, and many other countries. She was exiled from Paris several times by Napoleon, who opposed her political beliefs. IRVING PUTTER

STAFF. See MUSIC (The Language of Music).

STAFF is an inexpensive material resembling plaster. Builders use it as an exterior and interior finish for temporary structures. It is made of plaster of Paris and hydraulic cement, mixed in water with dextrine and glycerin. Staff is applied like plaster. See also PLASTERING.

STAFF, GENERAL. See GENERAL STAFF.

STAFF OF LIFE. See BREAD.

STAFFORD, THOMAS. See ASTRONAUT (table).

STAFFORDSHIRE BULL TERRIER is a powerful, heavy-set dog. A member of this breed stands from 14 to 16 inches (36 to 41 centimeters) tall and weighs from 28 to 38 pounds (13 to 17 kilograms). The dog has a broad head and a short, muscular neck. The coat of a Staffordshire bull terrier is short and smooth. It may be black, blue, brown, gray, red, tan, or white, or a combination of those colors.

Missy Yuhl

The Staffordshire Bull Terrier Originated in England.

The breed was developed during the early 1800's by miners of Staffordshire, England. They produced it by mating bulldogs with terriers. Staffordshire bull terriers were once used for dog fighting and for fighting bears and bulls. JOAN MCDONALD BREARLEY

See also AMERICAN STAFFORDSHIRE TERRIER.

STAFFORDSHIRE TERRIER. See AMERICAN STAFFORDSHIRE TERRIER.

STAG. See DEER.

STAG BEETLE is the name of a family of beetles in which some males have oddly enlarged jaws. These jaws look somewhat like the horns of a male deer and have given the beetle its name. In some cases, these "horns" are nearly as long as the body of the insect.

Common American species include the *giant stag beetle* of the southern states. It has *mandibles* (jaws) 1 inch (2.5 centimeters) long and a body 1½ to 2 inches (3.8 to 5 centimeters) long. The *pinching bug* of the eastern states is a stag beetle that flies by night. Adult stag beetles eat sap and honeydew. The eggs are laid in cracks in the bark of dead, decaying trees. They hatch into soft white grubs called larvae. See also BEETLE (pictures).

Scientific Classification. The stag beetle belongs to the stag beetle family, *Lucanidae*. The giant stag beetle is genus *Lucanus*, species *L. elaphus*. H. H. ROSS

STAGBUSH. See BLACK HAW.

STAGE. See THEATER; MOTION PICTURE; DRAMA.

STAGE, in turbines. See TURBINE (Turbine Terms).

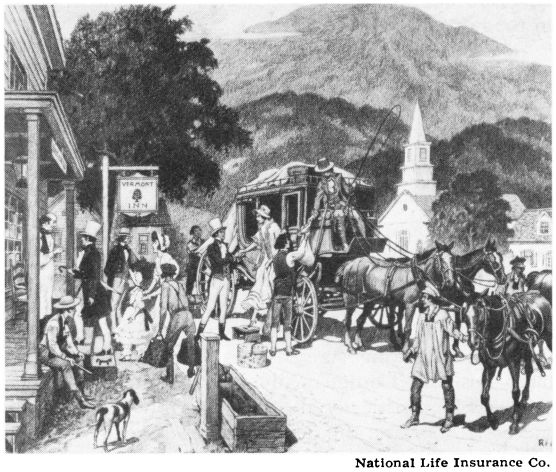
STAGE DESIGNER is an artist who designs the stage setting for plays, operas, motion pictures, and television programs. He sets the stage for the players and sets the mood for the audience. Theaters in ancient Greece, Rome, and medieval Europe used only a few pieces of scenery. In the 1700's, Italian painters designed elaborate settings, and the trend spread. See also THEATER. GLENN HUGHES

STAGECOACH was a horse-drawn coach used to carry passengers and mail on a regular route. Sometimes it also carried freight. The first long stage line was established about 1670 between London and Edinburgh, Scotland, a distance of 392 miles (631 kilometers).

Stagecoach lines were established in colonial America about 1756. They operated chiefly between Boston, New York, and Philadelphia. In 1785, Congress began mail service by stagecoach. Greater comforts were added to the coaches, such as springs and cushions. Many of the finest stagecoaches were made at Concord, N.H.

Early in the 1800's, travelers from Philadelphia, Baltimore, and Washington traveled to Ohio by the National Road. In elaborate Concord coaches drawn by six horses, they rode along at a brisk 10 miles (16 kilometers) per hour. The trip took two and one-half days. Horses were changed at relay stations every 15 or 20 miles (24 or 32 kilometers). Later, stagecoach lines operated in the West. But the railroads gradually replaced stagecoaches, except in remote regions. FRANKLIN M. RECK

See also WESTERN FRONTIER LIFE (Transportation).



National Life Insurance Co.

Stagecoaches provided the best transportation for passengers and mail between American cities in the 1700's and early 1800's.

STAGG, AMOS ALONZO (1862-1965), called *Football's Grand Old Man*, gained fame as the oldest active coach in the United States and the man with the greatest number of coaching seasons to his credit. He coached at the University of Chicago for 41 years. After he retired at the age of 70, he coached at College of the Pacific from 1933 to 1946, and at Susquehanna (Pa.) University from 1947 to 1952. He devised many new football developments, including the tackling dummy. Stagg was born in West Orange, N.J. LYALL SMITH

STAHL, GEORG. See CHEMISTRY (The Discovery of Oxygen).

STAIN is a special type of dye used to bring out the grain in wood. Stains are named according to the type of solvent used to dissolve the dye. Water, oil, and alcohol are the chief solvents of stain. Alcohol is considered the best solvent for wood stain because it does not cause the grain to rise above the surface of the wood, as water does. Oil penetrates wood and produces a lustrous finish, but has a tendency to smear into coats of varnish that may be applied over it. FRED FORTESS

STAIN REMOVING. See DRY CLEANING; CLEANING FLUID.

STAINED GLASS is colored glass that is assembled into pictures or decorative designs in religious and public buildings. Stained-glass windows are made up of many small pieces of colored glass.

Making Stained-Glass Windows. An artist designing a stained-glass window must take into consideration the style of architecture of the building in which the window will be set. He must know the amount of light the window will receive. And he must know the distance and direction the viewers will be from the window.

The artist first paints a small colored sketch of the window. He takes care that the lead divisions between the colored sections do not chop up the design. Next the artist makes a full-scale drawing, called a *cartoon*. The cartoon is used as a blueprint for making the window. Each tiny section of the cartoon is numbered to show where the various pieces of colored glass fit.

The glass used in the window is colored throughout its thickness by chemicals or dyes when the glass is manufactured (see GLASS [Colored Glass]). The thinness or thickness of each piece of glass determines how bright the color will be, and how much or how little light will come through that part of the window.

Workmen using diamonds or hardened-steel wheels cut the pieces of colored glass to fit each of the numbered parts of the cartoon. The jigsaw puzzle of glass pieces is then fitted together on a sheet of glass on top of the cartoon. Melted wax is used to fill the spaces between the colored glass pieces where the lead will be, and to hold the pieces on the sheet of glass. The artist can then view the design and make sure that it is complete and correct.

The artist paints details of his design on the pieces of glass with colored opaque enamels (see ENAMEL). The glass pieces are then placed in a furnace and baked at a temperature of about 2000° F. (1100° C) so that the enamel becomes part of the surface of the glass. The less enamel the artist uses on the glass, the more light the window will admit. The artist again puts the pieces together and studies the window. He may use acid to

cut away parts of the surface of the glass, to let more light through at the highlights of his design.

Finally, the workmen fit the bits of glass together with H-shaped strips of lead, called *cames*. Cracks between the lead and the glass are filled with putty to make the window waterproof. Workmen solder the joints of the lead strips and fit the window in place.

Early Stained-Glass Windows. The earliest known fragments of glass windows decorated with figures date from the 1000's. The oldest stained-glass windows still to be seen in their original setting are The Prophets, five larger-than-life-sized figures in the windows of the Cathedral of Augsburg, Germany. These windows were made about 1100 to 1130. The windows at St. Denis, in Paris, were created only a little later. The large stained-glass windows in the west front of the Cathedral of Chartres, France, date from about 1150.

In the late 1200's, more and more stained-glass window space was used in the great cathedrals of France. This form of decoration of churches was followed in England and Germany, but only rarely in Italy.

The Betrayal of Christ by an unknown German artist; Hessisches Landesmuseum, Darmstadt, Germany

A Stained-Glass Window of the 1200's shows Judas Iscariot giving Jesus Christ the kiss that betrayed Jesus to the Romans. During the Middle Ages, the church used such scenes in stained-glass windows to teach people stories from the Bible.

Window (1961) created for the synagogue at the Hadassah-Hebrew University Medical Center in Jerusalem, Israel; © Hadassah Medical Relief Association, Inc.

A Modern Stained-Glass Window by the artist Marc Chagall is one of a series that honors the 12 tribes of Israel. The window above represents the tribe of Zebulun. The fish and ship symbolize predictions in the Bible that the tribe would prosper near the sea.

Stained-glass windows were regarded as picture books to tell the story of mankind and of man's salvation. One of the greatest existing series of windows dates from 1200-1240 in the Cathedral of Chartres. These windows show scenes from the Old and New Testaments, the Virgin and Christ, Apostles and Saints. All are represented in the deep colors of the period, particularly the blues and the reds which glow and sparkle in the rays of the setting sun.

In the following years, through the 1500's, the demand for stained-glass windows continued, but the style changed. The early stained-glass windows used only a few colors and expressive designs. But as time went on, glass painters began to imitate oil painting by using flesh tones and perspective. As a result, stained-glass art lost much of the color and design values that had been so important. Finally, stained-glass windows fell into complete disregard.

Contemporary Stained-Glass Windows. Interest in stained-glass windows began to revive in the 1800's. Art lovers collected old stained-glass windowpanes and their fragments. Making stained-glass windows became a large business. Commercially this new start was successful, but artistically the new windows proved unsuccessful, because the artists were not creative. They either adopted the methods of oil painters or copied old Gothic designs.

In the late 1800's, changes for the better began to

be seen in stained glass. In the United States, Louis Comfort Tiffany began to experiment with new kinds of glass, and John La Farge created original designs and color schemes. In England, the William Morris movement kindled new interest in stained glass. In Holland and Germany, Jan Thorn Pricker established a new school of design for stained glass.

Following these new trends, artists such as Charles J. Connick and Wilbur Herbert Burnham became known. They designed colorful windows for the Cathedrals of St. John the Divine and St. Patrick in New York City, Grace Cathedral in San Francisco, and other churches throughout the United States. Emil Frei became recognized for his progressive design of such windows as those of St. Ann's Church in St. Louis, Mo. In France, Georges Rouault, Henri Matisse, and Fernand Léger designed windows for churches in Assy and other places. Reconstruction of churches damaged during World War II in England and Germany resulted in other outstanding stained-glass windows in contemporary designs. Marc Chagall's 12 windows showing the tribes of Israel are examples of outstanding recent stained-glass art. Completed in the early 1960's, the windows adorn the synagogue of the Hadassah-Hebrew University Medical Center in Jerusalem. HANS HUTH

See also RELIGION (color picture); TRACERY.

STAINLESS STEEL is the name of a family of alloy steels that resist *corrosion* (rust). As a family, the stainless steels have an easily-maintained, attractive appearance. They show remarkable strength and ductility and are unique in their general resistance to the elements and to most corrosives. Some 30 grades of stainless steels have been developed that have different combinations of strength, ductility, and resistance to corrosion and heat. Most stainless steels used in the home are highly polished, with a silvery appearance, but they do not need this finish to resist corrosion. *Stainless-clad steel* is commonly ordinary steel to which a thin layer of stainless steel has been bonded on one or both sides.

The most familiar use of stainless steel in the home is in kitchen knives, flatware, sinks, pots and pans, and other places where cleanliness and easy maintenance are essential. Stainless-steel equipment is used in hospitals, restaurants, chemical industries, dairies, and food-processing plants. Engineers use stainless steel parts for automobiles, aircraft, and railroad passenger cars. Scientists use microporous stainless steel, made with a nickel alloy, to filter gases, liquids, and small particles.

Chromium is the chief metal alloyed with iron, carbon, manganese, and silicon in making stainless steel. The more common stainless steels usually contain about 8 per cent nickel. One or more of the following elements also may be added to iron to make stainless steel: molybdenum, titanium, columbium, aluminum, nitrogen, phosphorus, sulfur, and selenium. Each of these elements modifies stainless steel so it can be used for a specific purpose. MAX D. HOWELL

See also HAYNES, ELWOOD.

STAINS, REMOVAL OF. See DRY CLEANING.

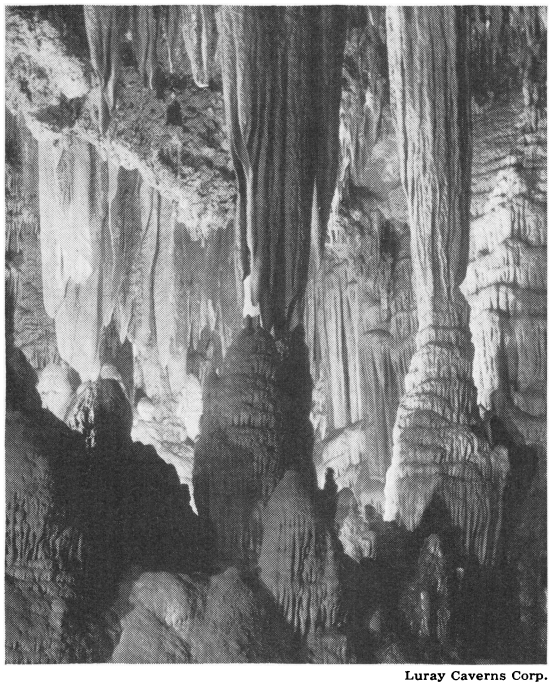
STAKE DRIVER. See BITTERN.

STAKED PLAIN. See TEXAS (Land Regions).

STALACTITE, *stuh LAK tite.* The beautiful stone formations that hang down from the walls and roofs of some caves are called *stalactites.* Most stalactites look somewhat like icicles. They usually form in limestone caves. They are caused when water drips through cracks in the roof of the cave and carries the mineral called *calcite* (calcium carbonate) with it. As the water evaporates, it leaves formations of the calcite hanging. Stalactites of basalt rock hang from the roofs of some lava caverns. Similar formations of ice have been found in the ice caves of Arctic regions.

Formations which build up from the floor of a cave are called *stalagmites* (see STALAGMITE). In the United States, excellent examples of stalactites and stalagmites exist in Carlsbad Caverns National Park in New Mexico, in Luray Caverns in Virginia, in Mammoth Cave in Kentucky, and also in Wyandotte Cave in southern Indiana. ELDRED D. WILSON

See also CALCITE; CAVE; NEVADA (picture).



Luray Caverns Corp.

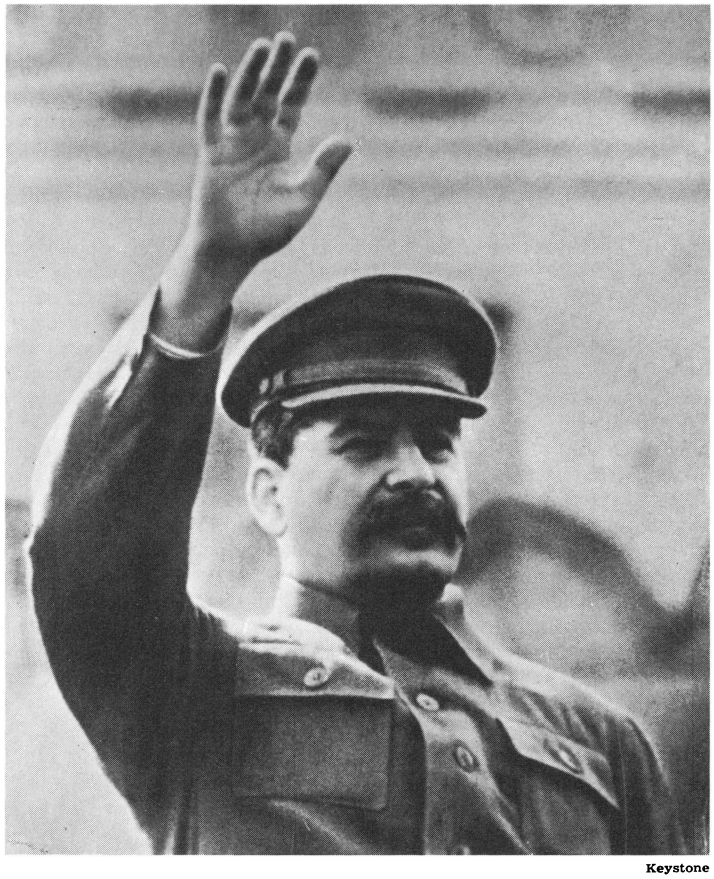
Stalactites and Stalagmites in Luray Caverns in Virginia's Shenandoah Valley form beautifully colored columns. The room shown above is called "The Cathedral" because the formations have the appearance of a pipe organ.

STALAGMITE, *stuh LAG mite.* Stalagmites are stone formations which rise up from the floors of caves, especially in limestone caverns. They form when water, dripping on the floor from the walls and roofs of the cave, carries with it deposits of calcium carbonate, or calcite. As the water evaporates, the calcite builds up into colorful formations which look like icicles upside down. Similar formations, which hang from the roof, are called stalactites (see STALACTITE). Sometimes stalagmites and stalactites join to form columns or stone curtains against the walls of the cave. ELDRED D. WILSON

See also CALCITE; CAVE (picture: Deep Underground); NEVADA (picture).

JOSEPH STALIN

Stalin's Signature



Keystone

Joseph Stalin Ruled the U.S.S.R. as Dictator from 1929 until 1953.

STALIN, *STAH lin,* **JOSEPH** (1879-1953), was dictator of the Union of Soviet Socialist Republics (U.S.S.R.) from 1929 until 1953. He rose from bitter poverty to become ruler of a country that covers about a sixth of the world's land area.

Stalin ruled by terror during most of his years as dictator. He allowed no one to oppose his decisions. Stalin executed or jailed most of those who had helped him rise to power because he feared they might threaten his rule. He also was responsible for the deaths of millions of Soviet peasants who opposed his program of *collective agriculture* (government control of farms). Under Stalin, the Soviet Union operated a worldwide network of Communist parties. By the time he died, Communism had spread to 11 other countries.

The Soviet people had cause to hate Stalin, and much of the world feared him. But he changed the Soviet Union from an undeveloped country into one of the world's great industrial and military powers. During World War II, the U.S.S.R. was an ally of the United States and Great Britain against Germany. However, Stalin sharply opposed and, on occasion, betrayed his allies even before the war was over. His last years of power were marked by the Cold War in which the nations of the Free World banded together to halt the spread of Communism.

Stalin had little personal charm, and could be brutal to even his closest friends. He seemed unable to feel pity. He could not take criticism, and he never forgave an opponent. Few dictators have demanded such terrible sacrifices from their own people.

After Stalin became dictator, he had Soviet histories rewritten to make his role in past events appear far greater than it really was. In 1938, he helped write an official history of the Communist party. Stalin had not played a leading part in the revolution of October, 1917 (November by the present Soviet calendar), which brought Communism to Russia. Lenin led the revolution and set up the world's first Communist government. But in his history, Stalin pictured himself as Lenin's chief assistant in the revolution.

Stalin died in 1953. He was honored by having his body placed beside that of Lenin in a huge tomb in Red Square in Moscow. In 1956, Nikita S. Khrushchev strongly criticized Stalin for his terrible crimes against loyal Communists. Later, in 1961, the government re-

Myron Rush, the critical reviewer of this article, is Professor of Government at Cornell University and the author of Political Succession in the U.S.S.R. *and* The Rise of Khrushchev.

named many cities, towns, and factories that had been named for Stalin. Stalin's body was taken from the tomb and buried in a simple grave nearby.

Early Life

Boyhood and Education. Joseph Stalin was born on Dec. 21, 1879, in Gori, a town near Tbilisi in Georgia, a mountainous area of southwestern Russia. His real name was Iosif Vissarionovich Djugashvili. In 1913, he adopted the name *Stalin* from a Russian word meaning *man of steel.*

Little is known about Stalin's early life. His father, Vissarion Ivanovich Djugashvili, was an unsuccessful village shoemaker. He is said to have been a drunkard who was cruel to his young son. Stalin's mother, Ekaterina Gheladze Djugashvili, became a washerwoman to help support the family. The Djugashvilis lived in a small shack. The first three children of the family died shortly after birth, and Stalin grew up as an only child. When Stalin was young, his father left the family and went to nearby Tbilisi to work in a shoe factory. The boy had smallpox when he was 6 or 7, and the disease scarred his face for life.

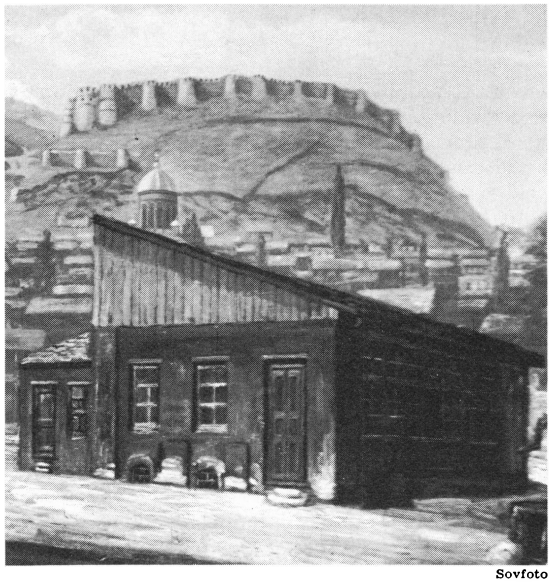
In 1888, at great sacrifice, Stalin's mother sent him to a little church school in Gori. He spent five years there and was a bright student. He then received a scholarship at the religious seminary in Tbilisi. Stalin entered this school in 1894 at the age of 14. He soon became known among his classmates for reading, debate, and good schoolwork. Some of his classmates later remembered that Stalin held grudges and seldom forgave persons who opposed him.

Stalin studied for the priesthood in the Georgian Orthodox Church. But he was repeatedly punished at the seminary for reading forbidden books. These books included Victor Hugo's novels about social conditions in France, and about French revolutionary movements. Stalin also became interested in the ideas of Karl Marx, a German social philosopher. The people of Tbilisi knew little of Marx and his theories about revolution. But political exiles from Moscow and St. Petersburg (now Leningrad) were beginning to bring Marxist pamphlets to Tbilisi and other smaller cities.

Czar Alexander III died in 1894, and his son, Nicholas II, became czar. Alexander had ruled Russia with complete power. He closely controlled the press, restricted education, and forbade student organizations. Nicholas continued his father's policies, and Russia made important economic and social progress. However, it was difficult to solve the country's social problems. The peasants were demanding more land. They could not raise enough food for the country on their small farms, and, at times, millions of persons faced starvation. The growing class of factory workers was discontented because of long hours and low wages. For a discussion of conditions in Russia at this time, see Russia (History).

In 1898, Stalin joined a secret Marxist revolutionary group. The Tbilisi seminary, like many Russian schools, was a center for the circulation of forbidden revolutionary ideas. In May, 1899, Stalin was expelled for not appearing for an examination. His interest in Marxism probably played a part in his dismissal.

Young Revolutionist. After Stalin left the seminary, he got a job as a clerk at the Tbilisi Geophysical Ob-



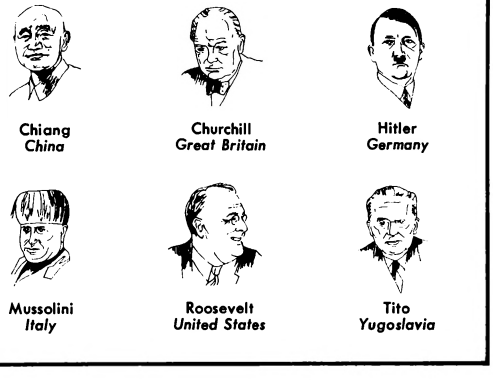
Sovfoto

Stalin's Birthplace was a two-room shack in Gori, a town in Georgia in southwestern Russia. A Soviet artist painted this picture of the shack. As a boy, Stalin studied to be a priest.

IMPORTANT DATES IN STALIN'S LIFE

1879 (Dec. 21) Born in Gori, Russia.
1899 Expelled from Tbilisi seminary.
1901 Joined the Russian Social Democratic Labor party.
1903 Exiled for the first of six times before the October revolution of 1917.
c. 1904 Married Ekaterina Svanidze.
1905 Met Lenin for the first time.
1912 Named by Lenin to Bolshevik party Central Committee.
1917 Named commissar of nationalities after Bolshevik revolution.
c. 1918 Married Nadezhda Alliluyeva.
1922 Appointed general secretary of Communist party.
1928 Began five-year plans to industrialize the U.S.S.R.
1929 Became dictator of the Soviet Union.
1935 Began great purge of Communist party members.
1939 The U.S.S.R. signed a nonaggression pact with Germany.
1941 Named himself premier of the Soviet Union.
1941 Germany attacked the U.S.S.R. during World War II.
1953 (March 5) Died in Moscow.

WORLD LEADERS OF STALIN'S TIME



servatory. Within a year, he began his career as an active revolutionist. In 1900, Stalin helped organize a small May Day demonstration near Tbilisi. He made his first public speech at the demonstration, which was held to protest working conditions.

In March, 1901, the czar's secret police arrested a number of socialists in Tbilisi. The police searched Stalin's room, but he was not there and escaped arrest. He left his job and joined the Marxist revolutionary underground movement that was springing up in Russia. To confuse the police, he changed his name to *Koba*, the name of a hero in a Georgian legend.

In September, 1901, Stalin began to write for a Georgian Marxist journal called *Brdzola* (The Struggle). By this time, he had read revolutionary articles written by Lenin. Stalin's first writings closely imitated the views of Lenin, but lacked Lenin's style or force. In November, 1901, Stalin was formally accepted into the Russian Social Democratic Labor (Marxist) party.

Using various false names, Stalin carried on underground activity in the Caucasus Mountains region. He organized strikes among workers in the Batum oil fields. He helped start a Social Democratic group in Batum and set up a secret press there.

In 1902, Stalin was arrested and jailed for his revolutionary activities. In March, 1903, the several Social Democratic groups of the Caucasus united to form an All-Caucasian Federation. Although Stalin was in prison, the federation elected him to its governing body. In November, 1903, he was transferred from prison and exiled to Siberia. Also in 1903, the Russian Social Democratic Labor party, which included many Social Democratic organizations, split into two major groups. V. I. Lenin headed the *Bolsheviks*, who demanded that party membership be limited to a small body of devoted revolutionists. The other group, called the *Mensheviks*, wanted a wider membership.

Stalin escaped from Siberia in January, 1904. He returned to Tbilisi and joined the Bolsheviks. Stalin met Lenin in Finland in 1905. Shortly before this time, Stalin married Ekaterina Svanidze, the sister of a schoolmate at the Tbilisi seminary. She died of tuberculosis in 1907. They had one son, Jacob, who died during World War II after being captured by the Germans. In 1918 or 1919, Stalin married Nadezhda Alliluyeva, a girl in her late teens who had been his secretary. She died mysteriously in 1932, either a suicide or a victim of Stalin's anger. Stalin and his second wife had a son, Vasily, and a daughter, Svetlana. Vasily, a Soviet air force general, died in an automobile crash after Stalin's death in 1953. Svetlana became a teacher and translator of English. She moved to the United States in 1967.

Between 1906 and 1913, Stalin was arrested and exiled a number of times. He spent 7 of the 10 years between 1907 and 1917 in prison or in exile. In 1912, Stalin was suddenly elevated by Lenin into the small but powerful Central Committee of the Bolshevik party.

In 1913, with Lenin's help, Stalin wrote a long article called "The National Question and Social Democracy." Iosif Djugashvili signed the article *Stalin*, a name he had just begun to use. Also in 1913, Stalin was arrested and exiled for the last time. Before his arrest, he served briefly as an editor of *Pravda* (Truth), the Bolshevik party newspaper.

Germany declared war on Russia in 1914 at the beginning of World War I. Stalin was in exile in Siberia, where he remained until 1917. He was turned down by the army in 1916 because a boyhood blood infection made it difficult for him to bend his left elbow.

By the end of 1916, Russia faced defeat in the war against Germany. Conditions became steadily worse at home. Food shortages in the capital, Petrograd (now Leningrad), led to riots and strikes. Finally, on March 15, 1917, Czar Nicholas II gave up his throne. A *provisional* (temporary) government, run mostly by liberals, was formed the next day. The government released Stalin and other Bolsheviks from exile. They returned to Petrograd on March 25. Stalin took over the editorship of *Pravda* from Vyacheslav Molotov. Lenin became concerned that Stalin did not strongly oppose the provisional government in *Pravda*. Lenin arrived in Petrograd from exile three weeks later and criticized Stalin for not taking a strong Bolshevik stand. Lenin launched a radical program for overthrowing the provisional government. This action led to the Bolshevik seizure of power in November, 1917. The month was October in the old Russian calendar, and the Bolshevik take-over is often called the *October Revolution*.

Rise to Power

The Bolshevik Revolution. During the period before the October Revolution, Stalin was not, as he later claimed, Lenin's right-hand man. He played an important, but not vital, part in the revolution. Lenin worked most closely with Leon Trotsky in the Bolshevik takeover of the government. After Stalin became dictator of the Soviet Union, he had history books rewritten to say that he had led the revolution with Lenin.

Lenin became head of the new government after the revolution, and named Stalin commissar of nationalities. Within a few months, opposition to the new government developed in many parts of the country. Armed uprisings broke out and grew into civil war. Stalin was active on the southern military front. In Stalin's version of history, he repeatedly corrected the mistakes of others. Stalin took credit for a victory at Tsaritsyn, the city later named Stalingrad (now Volgograd). Actually, Stalin's military role there was exaggerated.

During the civil war, the Russian Social Democratic Labor party was renamed the All-Russian Communist party (Bolshevik). Stalin became one of the five members of the newly formed *Politburo* (Political Bureau), the policy-making body of the party's Central Committee. In 1922, the Communist party's Central Committee elected Stalin as its general secretary.

Stalin Takes Over. The Bolsheviks won the civil war in 1920. They then began the task of rebuilding the war-torn country. At first, Lenin and the others were unaware of Stalin's quiet plotting. By the end of 1922, however, Stalin's growing power began to disturb Lenin. Before a series of strokes prevented Lenin from working, he wrote a secret note warning that Stalin must be removed as general secretary. He wrote that Stalin was too "rude" in personal relations and abused the power of his office. Because of his illness, Lenin was unable to carry out his plan to remove Stalin.

United Press Int.

Soviet Farm Workers had to work on government-controlled farms after Stalin began to end private farming in 1929.

Lenin died in 1924. The leading Bolsheviks finally learned of the secret note warning against Stalin, but they ignored it. They accepted Stalin's promise that he would improve his behavior. Instead, Stalin continued to build his own power. He cleverly used this power to destroy his rivals. In December, 1929, the party praised Stalin on his 50th birthday. He had become a dictator.

Dictator of the Soviet Union

The Five-Year Plan. In 1928, Stalin started the first of the Soviet Union's five-year plans for economic development. The government began to eliminate private businesses. Production of industrial machinery and farm equipment became more important, and production of clothing and household goods was neglected.

In 1929, Stalin began to *collectivize* Soviet agriculture. He ended private farming and transferred the control of farms, farm equipment, and livestock to the government. But the farmers resisted his order and destroyed about half of the U.S.S.R.'s livestock and much of its produce. As punishment, Stalin sent about a million families into exile. The destruction of livestock and grain caused widespread starvation. The economy moved forward, but at the cost of millions of lives.

During the 1930's, Stalin adopted a policy of *Russification*. The minority nationalities in the Soviet Union were subject to increasingly strict control by the government. In 1939, the Soviet Union seized a large part of Poland. In 1940, Soviet troops invaded the Baltic countries—Estonia, Latvia, and Lithuania. Stalin tried to destroy the middle classes in these countries. He set up Communist governments and joined them to the Soviet Union. See BALTIC STATES.

The U.S.S.R. and Germany Divided Poland by a treaty signed in September, 1939. Soviet foreign minister Vyacheslav Molotov, *seated*, and German foreign minister Joachim von Ribbentrop, *left*, signed the treaty as Stalin and an aide looked on.

United Press Int.

Rule by Terror. Under the czars, the Russian secret police had often arrested revolutionists and sent them into exile without trial. Stalin set up a police system that was far more terrible. Millions of persons were executed or sent to labor camps. Stalin also turned over many industries to the secret police, who forced prisoners to work in them. Fear spread through the U.S.S.R. as neighbors were ordered to spy on one another. The government broke up families and urged children to inform on their parents to the police.

In 1935, Stalin started a *purge* (elimination) of most of the old Bolsheviks associated with Lenin. During the next few years, he killed anyone who might have threatened his power. He also executed thousands of other Communist party members, including the chiefs and countless officers of the Soviet army. Stalin achieved his purpose. When he decided to cooperate with the German dictator Adolf Hitler in 1939, there was no one left to oppose his policies. Even when the Soviet Union later suffered terrible military defeats from Hitler's army, no political opposition to Stalin was possible.

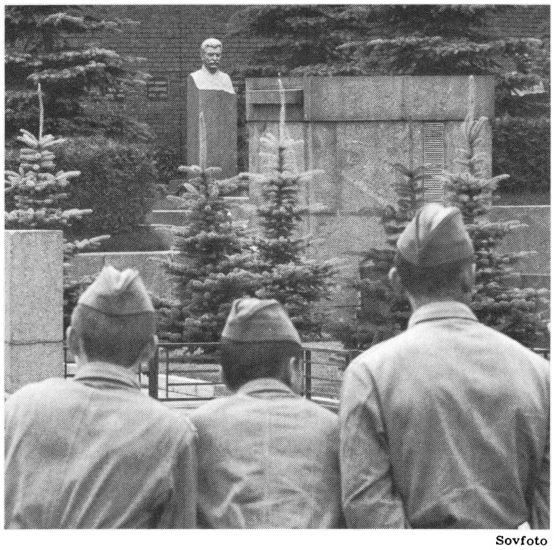
After World War II ended in 1945, Lavrenti P. Beria, chief of the secret police, became a leading figure in Stalin's government. Police control grew tighter. The bloody purges went on, but in secret rather than in public. No one was safe. Even Politburo members and Communist party leaders were purged and shot in 1949 and 1950. Anti-Semitism, which had been encouraged by Stalin during the 1930's, was now practiced throughout the country.

World War II. By the late 1930's, Adolf Hitler was ready to conquer Europe. Soviet leaders bargained unsuccessfully with the French and the British for a defense agreement against Germany. Then, on Aug. 23, 1939, the U.S.S.R. and Germany suddenly signed a treaty agreeing not to go to war against each other. In a secret part of the treaty, Stalin and Hitler also agreed to divide Poland between themselves.

On Sept. 1, 1939, German troops marched into Poland. On September 3, France and Great Britain declared war on Germany. World War II had begun. Germany quickly conquered western Poland, and the Soviet Union seized the eastern part. On September 28, Germany and the U.S.S.R. signed a treaty which set the boundaries for the division of Poland. The Soviet Union invaded Finland on Nov. 30, 1939, and, after a bitter struggle, took a large portion of that country.

By December, 1940, Hitler began planning an attack on the U.S.S.R. Prime Minister Winston Churchill of Great Britain and President Franklin D. Roosevelt of the United States told Stalin that their secret agents warned of a coming invasion. But Stalin ignored the warnings, as well as those of his own secret service.

In May, 1941, Stalin named himself premier of the Soviet Union. Germany invaded the Soviet Union the next month. In spite of the two extra years that Stalin had to get ready for a war, the country was not prepared. Because of Stalin's purge of the army, the U.S.S.R. did not have enough experienced officers. The country also lacked up-to-date weapons and equipment. The German army approached Moscow, the capital, in October, 1941, and many government offi-



Sovfoto

A Bust of Stalin gazes down on his grave, behind Lenin's tomb in Moscow's Red Square.

cials were moved to Kuybyshev. Stalin remained in Moscow to give hope and courage to the Soviet people. The army finally beat back German attacks on Moscow in the winter of 1941-1942. Stalin reached the height of his popularity during the war.

In March, 1943, Stalin took the military title of Marshal of the Soviet Union. Later in 1943, Churchill, Roosevelt, and Stalin met at Teheran, Iran. The "Big Three" agreed that the United States, Great Britain, and the U.S.S.R. would work together until Germany was defeated. The three leaders met again early in 1945 at Yalta in the Crimea to discuss the military occupation of Germany after the war. For the story of the Soviet Union in the war, see WORLD WAR II.

The Cold War. After the Allies defeated Germany in 1945, Stalin gradually cut off almost all contact between the U.S.S.R. and the West. Stalin used the Soviet army's presence in Eastern Europe to set up Communist governments in Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, and Romania. He also tried unsuccessfully to take over Greece, Iran, and Turkey. The nations of the Free World joined against the Soviet Union and its *satellites* (countries controlled by the U.S.S.R.) to halt the spread of Communism. This struggle became known as the Cold War (see COLD WAR).

Following World War II, Germany was divided into four zones, each occupied by American, British, French, or Soviet troops. Berlin, which lay deep in the Soviet zone, was also divided among the four powers. Stalin refused to cooperate in administering Germany, and in 1948, France, Great Britain, and the United States announced plans to combine their zones into the West German Federal Republic (West Germany). To prevent this action, Stalin tried to drive the Allies out of West Berlin by blockading the city. He hoped the blockade would prevent food and supplies from reaching West Berlin. But the Allies set up the Berlin airlift and supplied the city by airplanes for 11 months. Stalin was defeated, and he ended the blockade in May, 1949.

In 1948, Stalin expelled the Yugoslav Communist party from the *Cominform* (Communist Information Bureau), an organization of Communist parties in Europe. Marshal Tito, the Communist dictator of Yugoslavia, had refused to allow the Soviet Union to run his country. In 1949, Tito declared Yugoslavia's independence of control by Stalin and the Soviet Union.

Stalin's aggressive policies led the West in 1949 to form the North Atlantic Treaty Organization (NATO), a mutual defense organization.

During the Korean War (1950-1953), Stalin supported the Communist North Korean forces that invaded South Korea. Korea had been divided into two parts after World War II. At first, Soviet troops occupied the northern half, and American troops occupied the southern half, but both sides later withdrew their forces. North Korean troops then launched a surprise attack on South Korea in an attempt to unite the divided country by force. As a result, U.S. troops had to be sent back to Korea. The war ended a few months after Stalin's death. See KOREAN WAR.

Death. Early in 1953, Stalin prepared to replace the top men in the Soviet government. Apparently he was planning another great purge. Then, on March 4, 1953, the Central Committee of the Communist Party announced that Stalin had suffered a brain hemorrhage the night of March 1. Stalin died in Moscow on March 5, 1953.

Critically reviewed by MYRON RUSH

Related Articles in WORLD BOOK include:

Beria, Lavrenti P.
Bolshevik
Khrushchev, Nikita S.
Lenin, V. I.
Marx, Karl H.
Molotov, Vyacheslav M.
Politburo
Potsdam Conference
Russia
Teheran Conference
Tito
Trotsky, Leon
World War II
Yalta Conference

Outline

I. Early Life
- A. Boyhood and Education
- B. Young Revolutionist

II. Rise to Power
- A. The Bolshevik Revolution
- B. Stalin Takes Over

III. Dictator of the Soviet Union
- A. The Five-Year Plan
- B. Rule by Terror
- C. World War II
- D. The Cold War
- E. Death

Questions

Why did Stalin have Soviet history books rewritten after he became dictator?
What does the word *Stalin* mean in Russian?
What were the Five-Year Plans?
Why was Stalin expelled from the Tbilisi seminary?
Why did Stalin set up the blockade of West Berlin?
What position did Stalin receive in the Bolshevik government after the October Revolution?
Why did Lenin plan to remove Stalin as general secretary of the Communist Party?
Why was Stalin rejected for military service during World War I?
Why did the U.S.S.R. have difficulty meeting the attack by Germany in World War II?
Why did the Western powers set up the North Atlantic Treaty Organization (NATO)?

Reading and Study Guide

See *Joseph Stalin* in the RESEARCH GUIDE/INDEX, Volume 22, for a *Reading and Study Guide.*

STALINABAD. See DUSHANBE.

STALINGRAD. See VOLGOGRAD.

STALINGRAD, BATTLE OF, one of the most important battles of history, marked a turning point in World War II. During the five-month struggle, the Russians kept German troops from capturing Stalingrad (now Volgograd), an important Russian industrial city on the Volga River. The German defeat at Stalingrad ended the Nazis' eastward advance into Russia. The invading German troops had to retreat from the Caucasus oil fields and the lower Don River regions. During the battle, the German army lost about 350,000 soldiers, including about 90,000 prisoners. The prisoners included 24 German generals. Snow and bitter cold took a heavy toll of German troops.

The German Sixth Army launched its drive on Stalingrad on Aug. 21, 1942, from positions about 40 miles (64 kilometers) away on the Don River. By August 23, German tanks had reached the Volga River, north of Stalingrad. Gradually, they forced their way into the city. By November, German forces had isolated Russian troops in four "pockets" along the riverbank in the city. German and Russian units fought hand-to-hand for control of single streets, houses, and factories. When the Volga froze over, Russian troops pushed supplies across on the ice at night.

Russian armies north and south of Stalingrad counterattacked on November 19. The Russians met west of Stalingrad on November 23, completely surrounding the German units in and near the city.

Parimage from P.I.P.

The Russians Raised a Flag at Stalingrad after the Germans surrendered on Jan. 31, 1943, following a five-month battle.

Nazi dictator Adolf Hitler ordered his generals to continue the battle for Stalingrad. He sent other German units to help the troops in the city, but the relief forces could not break through the Russian lines. The Russians hammered away at the hungry, half-frozen German troops. Finally, German Field Marshal Friedrich Paulus, Sixth Army commander, surrendered on Jan. 31, 1943. WILLIAM A. JENKS

See also RUSSIA (World War II); VOLGOGRAD; WORLD WAR II (On the Russian Front; picture and map: Stalingrad).

STALINO. See DONETSK.

STALL. See AIRPLANE (Stalling; Measuring Flying Speed).

STALLION. See HORSE (Horse Terms).

STALWARTS. See GARFIELD, JAMES ABRAM (Political Career); REPUBLICAN PARTY (The Radical Republicans and Reconstruction).

STAMBOLIISKI, ALEXANDER. See BULGARIA (After World War I).

STAMEN. See FLOWER (The Parts of a Flower; color diagrams: Parts of a Flower).

STAMFORD, Conn. (pop. 108,798; met. area 206,340), lies about 35 miles (56 kilometers) northeast of New York City, on Long Island Sound. For location, see CONNECTICUT (political map). Many of Stamford's citizens work in New York City. Stamford produces bearings, drugs, electrical equipment, furniture, locks, and plastics. The city has a museum, a public library, a civic music society, and several choral groups.

Stamford was settled in 1641 and incorporated as a city in 1893. In 1949, the township and city of Stamford merged under one government. Stamford has a mayor-council government. ALBERT E. VAN DUSEN

STAMFORD BRIDGE, BATTLE OF. See HAROLD, or HARALD (III).

STAMMERING. See STUTTERING AND STAMMERING.

STAMP is an official mark or seal or a small printed piece of paper with one glued surface. Many documents are not legal until they carry a government stamp. For example, the government may require the payment of a one-dollar tax on a real-estate deed. The collector pastes a revenue stamp of one dollar in value on the deed, as proof that the tax was paid.

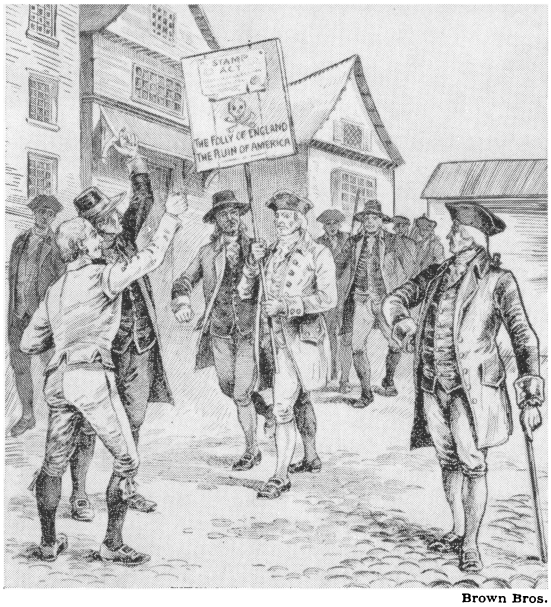
The Dutch levied the first stamp taxes in 1624. In 1694, the English used the stamp plan to raise money for carrying on a war with France. The British Stamp Act of 1765 was one of the direct causes of the American colonial revolt against Great Britain.

In 1814, stamp taxes became a part of the fiscal system of the United States. In 1862, the American Congress passed an important stamp law. The law required that legal papers and certain kinds of packages carry government stamps. The purpose of the law was to raise funds to pay some of the expenses of the Civil War. The law was repealed when revenue was no longer needed to pay war expenses. New stamp laws, passed during the Spanish-American War and World War I, helped raise money to pay the costs of war.

Government stamps for raising money are known as internal revenue stamps. Until 1959, the United States government required that such stamps be placed on luxuries such as tobacco and liquor. Some states also tax these luxuries, and require that they be stamped.

During World War II, the United States government offered war savings stamps for sale to citizens. These stamps raised funds for the war. Savings stamps are still sold. Another kind of stamp, the ration stamp, came into use during World War II. The purpose of the ration stamp was to divide food and clothing equally among civilians. However, people are probably most familiar with the postage stamp. PAYSON S. WILD

See also INTERNAL REVENUE; POST OFFICE (Postage Stamps); STAMP ACT; STAMP COLLECTING; TRADING STAMPS.



Brown Bros.

Colonists Demonstrated Against the Stamp Act in New York City in 1765. The man carrying the sign is being cheered on by other colonists, except by the one at the right.

STAMP ACT. The British Parliament passed the Stamp Act in March, 1765. Its purpose was to raise funds to help support the British army stationed in America after 1763. The act specified that Americans must buy stamps for deeds, mortgages, liquor licenses, law licenses, playing cards, and almanacs. Even newspaper owners and publishers had to purchase stamps for their publications.

The Stamp Act was unpopular throughout the colonies. Societies organized to protest the sale of stamps. In cities and towns the slogan became "no taxation without representation."

The Virginia Assembly declared that the act was illegal and unjust. The assembly passed resolutions against taxation by the British Parliament. The Massachusetts House of Representatives invited all colonies to send delegates to a general congress. The colonies which accepted the invitation were New York, New Jersey, Rhode Island, Pennsylvania, Delaware, Connecticut, Maryland, South Carolina, and Massachusetts.

The Stamp Act Congress met in New York in October, 1765. It declared that stamp taxes could not be collected without the people's consent. American resistance forced the British Parliament to repeal the Stamp Act in 1766. JOHN R. ALDEN

See also ADAMS, JOHN (In New England); REVOLUTIONARY WAR IN AMERICA (The Quartering and Stamp Acts).

These Three Stamps were used by the British government under the Stamp Act it imposed upon the American colonies.

STAMP COLLECTING is one of the most popular collecting hobbies in the world. Young persons, old persons, rich persons, and poor persons in every country collect stamps. Stamp collecting has been called "the hobby of kings and the king of hobbies." King George V of England, Franklin D. Roosevelt, and many other famous persons have collected stamps. Students of stamps are called *philatelists*. The name comes from two Greek words, *philos*, meaning *loving*, and *atelos*, meaning *free of tax*, or *paid*. Stamps are signs that the postage, or tax, has been paid.

Origins

Great Britain issued the first stamps to prepay postage on letters on May 6, 1840. These first stamps were a one-penny stamp (now known as "The Penny Black") and a two-pence stamp. Complete envelopes designed by William Mulready were also sold in the same values. But these were discontinued.

The United States did not issue any stamps until 1847. By that time several other countries had already tried the newly invented stamp. Among them were Brazil, Mauritius, and the *cantons* (states) of Switzerland. By 1860 almost every country had adopted stamps as a method of paying postage.

No one knows exactly when stamp collecting started. It probably occurred right after the first stamp was issued. We do know that the first stamp catalog was published in 1864 by an Englishman named Mount Brown. Since then catalogs of stamps have been published in almost every country. A great many books and magazines about stamps have also been published.

People soon discovered that some stamps were harder to find than others, because smaller quantities of them were printed. Collectors traded rare stamps and soon began selling them to each other. Prices rose as more people began collecting stamps. A two-penny Hawaiian Missionary stamp was sold for $41,000 in 1963 and resold for more than $50,000 in 1973. A one-penny 1856 British Guiana stamp sold for $280,000 in 1970. Sometimes errors are made in printing stamps. Such stamps are usually rare and may become very valuable. For example, about 100 24-cent United States airmail stamps were issued in 1918 with the airplane mistakenly printed upside down. One of these stamps was sold at auction in 1974 for almost $50,000.

Ways in Which Stamps Differ

Small differences in stamps mean a great deal to the stamp collector. Stamps which look the same to the beginner might seem entirely different to the expert.

Philatelists study many things, such as the paper and inks used, the way the stamps are separated, the printing process, and postal history.

Paper. The surface of paper may be finished in various ways. Paper with a plain finish is called *wove*. Paper which looks as though it has bars in it when it is held up to the light is known as *laid*. Tiny pieces of colored silk like those in a dollar bill are used in *silk paper*. Pieces of silk so small they can hardly be seen are used in *granite paper*, which is grayish in color.

Sometimes paper is made with a design called a *watermark*, which is pressed into the wet paper with wire. The wire can be laid in any shape wanted. Stamps may look the same on the surface, but have different

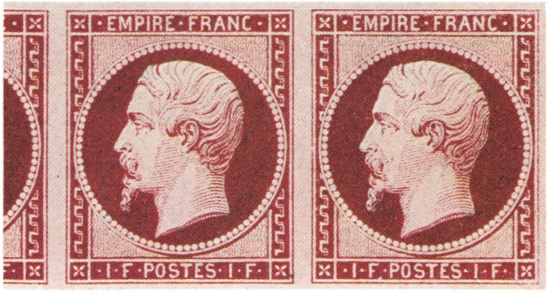
WORLD BOOK photo

A Stamp Collector mounts his stamps in an album. A stamp catalogue, *rear,* provides information about various stamps. The collector uses a magnifying glass to examine the details of a stamp. He holds the stamp with tweezers to keep it from being soiled. He uses stamp hinges, *right,* to mount the stamps in his album.

RARE AND UNUSUAL STAMPS

Collectors especially value stamps that are rare or have some unusual feature. A number of stamps, called *errors,* have become valuable because of a printing mistake, such as part of the design being upside down. Some collectors have paid thousands of dollars for one error.

The World's Most Valuable Stamp was issued in British Guiana in 1856. The only known copy was sold in 1970 for $280,000.



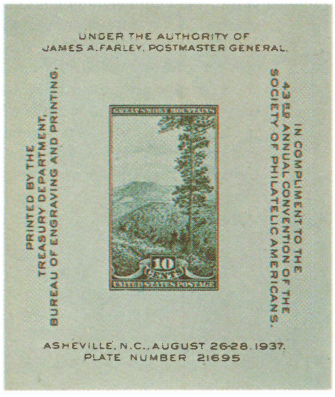
Early Stamps, such as the French issue from the 1850's shown above, had no perforations. Collectors call these stamps *imperforates.*

An Inverted Center makes this 1918 airmail stamp one of the most valuable errors among all United States stamps.

Robert A. Siegel, Inc.

A Tête-bêche Error occurs when one stamp in a series is printed upside down. The pair shown above was issued in France in 1870.

STAMP COLLECTING SPECIALTIES



Souvenir Sheets have been issued periodically by the U.S. Post Office since 1926 to honor major conventions of stamp collectors.

A Plate Block consists of four or more connected stamps with the serial numbers of the plates from which the stamps were printed.

Stamps Showing Birds attract collectors who specialize in beautiful stamps or in issues dealing with the same general subject.

WORLD BOOK photos

A First Day Cover is an envelope bearing a stamp canceled on its first day of issue. On that day, the U.S. Postal Service sells the stamp in only one selected city. The postmark on the example above shows that the first day of issue was Jan. 26, 1973, in Philadelphia. Private companies sell collectors first day covers decorated with specially designed pictures called *cachets*.

Robert A. Siegel, Inc.

The First Stamps Issued by the U.S. Post Office appeared in 1847. They bore the portraits of George Washington and Benjamin Franklin. Franklin was the first U.S. postmaster general.

WORLD BOOK photos

Commemorative Stamps honor events. The above stamps commemorate the first astronaut to step on the moon and the 150th anniversary of the birth of the author Henry David Thoreau.

watermarks. Philatelists consider these as different stamps. The watermark can be seen by holding the stamp up to the light, or by placing it face down in a black dish and pouring watermark fluid on it.

Ink. Stamps are printed with different colored inks. Variations of the color of the basic ink make the stamps different for the collector. For example, a blue stamp differs from an ultramarine stamp.

Printing. A stamp may be printed by one of three methods—*relief*, *planographic*, and *intaglio*. Relief printing is made from a raised design. Planographic printing is made from a design level with the surface, and intaglio is printed from a design cut lower than the surface. The most common forms of planographic printing are *offset* and *lithography*. One form of intaglio printing used for stamps is called *engraving*. The ink is slightly raised, just as it is on an engraved calling card. Another intaglio process is *gravure*. See PRINTING.

Separations. The first stamps had to be cut apart with scissors. Such stamps are called *imperforate*. Soon *perforations* (little holes) were punched between the rows of stamps. Stamps which have a different number of holes per inch along any edge are also considered as different stamps. Sometimes the separations are slits cut with a knife between the stamps, but with no paper punched out. This form is referred to as a *roulette*.

Cancellations. The marks placed on a stamp to show that it has been used are called a *cancellation*. Cancellations show postal history. Used stamps are often left on the envelopes, and early stamps are much more valuable that way. Envelopes with a stamp canceled the first day it was used are called *first day covers*. Collectors now prize such cancellations.

Surcharged Stamps. Countries often change stamps by overprinting (surcharging) something new on an old stamp, instead of issuing a new one. A new value may be printed on an old stamp. When a country is overrun in war, the conquerors often print their names on the stamps of the fallen country.

Special Stamps. Many special types of stamps are issued, in addition to plain postage stamps. A country may honor or commemorate some event or famous person by issuing *commemorative* stamps. The United States issued its first commemorative stamp in 1893. It was called the Columbian issue, in honor of the four-hundredth anniversary of the discovery of America. A stamp which is sold for more than the cost of postage is called a *semipostal*. Such stamps have been issued by many countries, but not by the United States. Extra funds obtained from such stamps have been given to charity, and to help finance fairs, youth clubs, and the rebuilding of a cathedral.

Many types of special stamps are issued by various countries of the world. Among such stamps are air mail, parcel post, official, postage due, provisional stamps for emergencies, pneumatic tube, special delivery, and personal delivery. Other types include registration, occupation during war, postal savings, newspaper, special handling, and combinations of special services.

Other Reasons for Collecting. Not all people collect stamps because they are rare or special, or have certain markings. Many people like to collect them just for the pictures of odd and out-of-the-way places and things. Some people collect stamps of one country only. Others collect only stamps showing birds, or railroads, or ships. Still others collect stamps of only one color, such as purple stamps. Specialists may collect only one issue or the varieties of one issue. The reason for collecting does not matter as long as the collector has fun. CHARLESS HAHN

See also POST OFFICE; STAMP.

STAMP WEED. See INDIAN MALLOW.

STANDARD. See FLAG (table: Flag Terms).

STANDARD BOOK NUMBER is a group of nine numbers identifying a book and its publisher. Standard book numbers simplify book ordering processes. Booksellers, librarians, and others who handle large numbers of books can send and receive orders faster and more efficiently, using standard book numbers.

A standard book number has three parts, separated by hyphens or spaces. The first four numbers are called the publisher prefix. They represent the publisher of a book. The second four numbers, called the title prefix, represent the book title. The last number is a check *digit* (number under 10). As the standard book number goes through a computer, the check digit indicates errors that may have been made when the number was handwritten.

The standard book number system was first used in Great Britain in 1967. Following general agreement among publishers, the United States adopted the sys-

tem later that year. The developers hope that eventually all countries will use standard book numbering.

STANDARD CANDLE. See CANDELA.

STANDARD GAUGE. See RAILROAD (Tracks).

STANDARD OF LIVING usually refers to the economic level at which an individual, family, or nation lives. Economists may measure this level by determining the value of the goods and services *consumed* (used) by the individual, family, or nation during a given period. The term *standard of living* may also refer to the goals that a person sets for himself as a user of goods, services, and leisure. That is, the term may be defined as the level of comfort and happiness that a person would like to reach. When his needs and wants have been satisfied, he has achieved his standard of living.

Needs and Wants. Human beings have many needs and wants. Their basic needs have always included food, clothing, and shelter. To these may be added a number of other needs, depending upon the society in which a person happens to live. In many parts of the world, artificial light and artificial heat have become basic needs. In the United States, transportation, leisure, schooling, recreation, and a sense of belonging to something are generally held to be needs. Wants are even less definite than needs. So far as anyone knows, there is no limit to the range of human wants.

When we talk about the standard of living of a nation, it is a little like talking about the "average man." No nation has a general standard of living for everyone, any more than it has an average citizen. The size of the average paycheck is no indication of a nation's standard of living. The cost of living varies over the world. The man who earns $100 a month in one part of the world may live better than one who is paid $100 a week in another place, because the first man's lower wages buy more goods and services to satisfy his needs.

Economists may estimate a nation's living standard by determining how much income the nation's individuals spend for food, a basic need. A nation in which most individuals must spend 75 per cent or more of their income for food may be said to have a low living standard. A nation in which most individuals spend 25 per cent or less of their income for food may be said to have a high living standard. Economists face several problems when they try to determine what shares of individual income are spent for particular items other than food. A major problem is that many such items are bought by families rather than by individuals.

Area Differences. At present, the world supports about 4 billion people. At the American standard of grain consumption, only half this number could live. On the other hand, the world could support an additional billion people at present production if everyone went on the Asiatic standard of living. The whole world, with its present population, could be supplied with grain at the European standard of grain consumption before World War II. This would put an end to starvation and misery in Asia, but it would sharply cut the American standard of grain consumption.

The situation is even more striking when it comes to other foods, such as meat or dairy products. The North American standard of living calls for about 3 pounds (1.4 kilograms) of meat per person a week. Europe gets about 2 pounds (0.9 kilogram), and South America about $1\frac{1}{2}$ pounds (0.7 kilogram). Asia and Africa use only $\frac{1}{3}$ pound (0.2 kilogram) per person a week. If the world's animal foods were equally distributed at the present rate of livestock production, each person would get about 1 pound (0.5 kilogram) of meat per week.

The United States is said to have the world's highest standard of living because more goods per person are consumed there than in any other nation. But this measure of living standards does not accurately show how Americans live. First, it does not show how the consumption of goods actually is divided among the American people. Also, this measure does not take into account certain conditions—such as overcrowding and pollution—that may make life unpleasant in parts of the United States. Finally, a high consumption level does not mean that the people's wants have all been satisfied. In general, however, Americans enjoy more comforts—including better clothing and housing, greater educational opportunities, and more healthful food—than any other people.

LOUIS W. STERN

Related Articles in WORLD BOOK include:

Consumption	Inflation and Deflation
Cost of Living	National Income
Gross National Product	Technology
Income	Wages and Hours
Industrial Revolution	World (The Wealth of Nations)

STANDARD OIL COMPANY. In 1859, Edwin L. Drake, a retired railroad conductor, drilled the first commercially successful oil well in the United States near Titusville, Pa. In 1863, John D. Rockefeller and his partners organized Andrews, Clark, and Co., which later became a part of the Standard Oil Company. The new firm built a large oil refinery in Cleveland, and began to sell oil at home and abroad. The new business expanded rapidly. In 1870, Rockefeller and his associates formed the Standard Oil Company of Ohio and began to buy other refineries.

From 1870 to 1882, Rockefeller and his associates bought practically all the refineries in Cleveland, and

A MEASURE OF STANDARDS OF LIVING

The standard of living for a nation is sometimes measured by dividing its *personal consumption expenditures* by its population. These expenditures represent the value of goods and services purchased by individuals and nonprofit institutions during a given period. However, to make an accurate comparison of living standards, a person must allow for differences in the purchasing power of money from nation to nation and from year to year. He must also allow for differences in the availability of various goods and services. This table lists the 20 leading non-Communist nations in personal consumption expenditures per person in 1973.

United States	$3,827	The Netherlands	$2,411
Switzerland	$3,579	Belgium	*$2,214
Canada	$3,135	Iceland	*$2,081
Sweden	$3,077	Austria	$1,933
Germany (West)	$2,966	Japan	$1,890
Denmark	$2,934	Finland	$1,861
France	$2,767	Great Britain	$1,858
Australia	$2,725	Italy	$1,552
Luxembourg	$2,598	New Zealand	*$1,460
Norway	$2,575	Ireland	$1,308

*1972, latest available figures.

Sources: *UN Monthly Bulletin of Statistics*, February, 1975; *International Financial Statistics*, March, 1975.

acquired refineries in other cities. They developed a pipeline system, purchased new oil-producing lands, and created an efficient organization to market their products. To unify the management of the companies and to overcome certain legal difficulties, they transferred the stock of all companies to the newly formed Standard Oil Trust in 1882 (see TRUST). This made Standard Oil the biggest company in the oil industry. The trust controlled about 90 per cent of the country's refining capacity, and almost as much of its pipelines.

After 1870, Rockefeller and the business practices of Standard Oil came under bitter attacks from newspapers, magazines, books, state and federal investigating agencies, and many courts. In 1892, the supreme court of Ohio dissolved the trust. All the companies in the trust had to operate separately, as they did before the trust was formed in 1882. In 1899, the Standard Oil Company of New Jersey amended its charter in an attempt to preserve the vast oil empire and to provide centralized direction for all the companies in the empire. The new company gave its stock in exchange for certificates of companies in the dissolved trust. It held stock in about 20 constituent companies.

The reorganization of Standard Oil of New Jersey made the company one of the richest and most powerful holding companies in the world. In 1906, the federal government, under the Sherman Antitrust Act, brought suit against the combination. In 1911, the Supreme Court of the United States ordered the company to dissolve under the provisions of the Sherman Antitrust Act. This action forced 33 companies of Standard Oil of New Jersey to become separate, independent, competing companies with no corporate connections with each other or with the Standard Oil Company of New Jersey. In 1972, Standard Oil (New Jersey) changed its name to Exxon Corporation.

Today, the largest of the old Standard Oil companies include Atlantic Richfield Company, Exxon Corporation, Mobil Oil Corporation, Standard Oil of California, Standard Oil (Indiana), and Standard Oil (Ohio). For the sales, assets, and employees of all the above companies, see MANUFACTURING (table: 100 Leading U.S. Manufacturers).

Exxon Corporation ranks as the world's largest petroleum company. It conducts business in the chemical, energy, gas, and oil industries in the United States and other countries. Exxon's chief divisions include Exxon Company, U.S.A.; Exxon International Company; and Exxon Chemical Company. Imperial Oil Limited in Canada and Creole Petroleum Corporation in Venezuela are affiliated with Exxon Corporation.

Standard Oil of California produces, refines, and markets oil in the West, the Southwest, the Southeast, and in 12 eastern states. It has 50 subsidiaries in the United States and abroad. Arabian American Oil Company, Trans-Arabian Pipe Line Company, and the Caltex Companies are affiliated with it.

Standard Oil (Indiana), a major international oil company, is a parent company for domestic and foreign activities. The American Oil Company is its United States refining and marketing subsidiary. Amoco Production Company is its United States exploration and production subsidiary.

Standard Oil (Ohio) is the oldest of the Standard companies. It markets its products in Ohio and surrounding states. It produces oil in Illinois, the Southwest, Canada, Venezuela, and Iran. PAUL H. GIDDENS

See also ROCKEFELLER (family).

STANDARD SCHNAUZER. See SCHNAUZER.

STANDARD TIME is a worldwide system of uniform time zones. This system divides the world into 24 zones. Twenty-three zones are full zones and one zone is divided into two half zones. Each full zone is 15° longitude wide (see LONGITUDE). The difference in time between that of any full zone and its neighbor is exactly one hour. Within each zone, all clocks keep the same time, except for some local variations.

Time Zones. The *local*, or *sun*, time for any specific location depends on its longitude. There is a difference of 4 minutes for each degree of longitude, or a difference of an hour for every 15°. Under standard time, the time kept in each zone is that of the central *meridian*, or longitude line (see MERIDIAN). The central meridians are those 15°, 30°, 45°, and so on, east or west of the prime meridian. In theory, the zone boundaries should extend $7\frac{1}{2}°$ on either side of the central meridian. In practice, the boundaries are irregular lines. This is to avoid inconvenient changes in time. For example, in the United States, zone boundaries often are located so that a state will lie entirely within one time zone. The Department of Transportation has the authority to establish limits for time zones in the United States. Canada does not have a federal standard time law. Its time zones generally have the same names as those used in the United States.

The standard time zones in the United States and Canada are—from east to west—Atlantic, Eastern, Central, Mountain, Pacific, Yukon, Alaska-Hawaii, and Bering. For the boundaries of these zones, see TIME (map).

In summer, the residents of most states advance their clocks one hour to use daylight saving time. An act of Congress, which became effective in 1967, declared that daylight saving time must be used throughout a state or not at all. But an amendment to the act in 1972 allows states that lie in more than one time zone to use daylight time in one zone without using it in the other. See DAYLIGHT SAVING.

History. Before the adoption of standard time, each city in the United States kept the local time of its own meridian. With the growth of railroads, these differences caused difficulties. Railroads that met in the same city sometimes ran on different times. In 1883, the railroads of the United States and Canada adopted a system for standard time. In 1884, an international conference met in Washington, D.C., to consider a worldwide system of standard time. The meridian passing through Greenwich, England, was chosen as the prime meridian. In 1918, Congress gave the Interstate Commerce Commission authority to establish limits for time zones in the United States. Congress transferred this authority to the Department of Transportation in 1967.

Today, nearly all nations keep standard time. Only a few small countries and some other regions keep time that differs by a half hour or by some minutes and seconds from standard time. WILLIAM MARKOWITZ

See also FLEMING, SIR SANDFORD; TIME.

Library of Congress

Captain Miles Standish led an attack on Merry Mount in 1628. The Pilgrims destroyed the settlement and captured Thomas Morton, who had been selling guns to the Indians. Standish also led expeditions against the Indians, and helped explore Cape Cod.

STANDARDBRED. See HORSE (Light Harness Horses; picture); HARNESS RACING.

STANDARDS, BUREAU OF. See NATIONAL BUREAU OF STANDARDS.

STANDBY DRAFT SYSTEM. See DRAFT, MILITARY.

STANDISH, MILES (1584?-1656), came to America with the Pilgrims in the *Mayflower*. He was not a Separatist, and never joined the Pilgrim Church. But he helped the Pilgrims in their plans and in training a militia. See PILGRIM; PLYMOUTH COLONY.

Short but stocky, Standish had red hair and a florid complexion which turned livid when he grew angry. "A little chimney is soon fired," commented one of his enemies. But no one questioned his bravery. Single-handed, he attacked a threatening Indian chief, Wituwamat, and brought his head back to Plymouth. His watchfulness probably saved the colony from destruction by Indians in its early years.

In 1625, the colonists sent him to England to get a more favorable agreement with the merchants who were financing the colony. He could not accomplish much, partly because of the plague then raging in London. Standish was one of the leaders who assumed the colony's debts. He served as assistant governor from 1624 or perhaps from 1633 on, and as Plymouth's treasurer from 1652 to 1655. He helped found Duxbury, Mass., and moved there about 1632. His statue overlooks the town and Plymouth Bay.

Standish was born in Lancashire, and fought as a young man against the Spaniards in The Netherlands. Henry W. Longfellow's account of him in *The Courtship of Miles Standish* is entirely fictitious (see COURTSHIP OF MILES STANDISH, THE). BRADFORD SMITH

STANDPIPE. See RESERVOIR.

STANFIELD, ROBERT LORNE (1914-), became leader of Canada's Progressive Conservative Party in 1967. He succeeded former Canadian Prime Minister John G. Diefenbaker. Stanfield failed to lead his party to a parliamentary majority in the general elections of 1968, 1972, and 1974. He served as premier of Nova Scotia from 1956 to 1967.

Stanfield was born in Truro, N.S. He graduated from Dalhousie University in 1936 and Harvard University in 1939. In 1948, he became leader of the Nova Scotia Progressive Conservative Party. Stanfield was elected to the Nova Scotia Legislature in 1949. His efforts in encouraging the establishment of new industry in the province helped him win re-election in 1953, 1956, 1960, 1963, and 1967. Stanfield won election to the national House of Commons after the Progressive Conservatives made him their leader. E. D. HALIBURTON

STANFORD, LELAND (1824-1893), was a railroad builder, a governor of California, and a United States Senator. In 1885, he founded Stanford University in memory of his son, with a gift of land and securities. Stanford was born in Watervliet, N.Y. He studied law and started his practice in 1848 in Port Washington, Wis. In 1852, Stanford moved to California and opened a general store. He entered politics and became governor of California in 1862. He helped keep the state loyal to the Union during the Civil War. After his term as governor ended in 1863, Stanford joined others in building the Central Pacific and Southern Pacific railroads. He was president of both railroads. Stanford was a Republican U.S. senator from California from 1885 until his death. W. H. BAUGHN

STANFORD-BINET TEST. See INTELLIGENCE QUOTIENT.

STANFORD RESEARCH INSTITUTE is a nonprofit, independent contract research organization. The institute performs both basic and applied research for industry, government, and the public. A staff of about 2,700 scientists provides research services in economics, engineering, the physical and biological sciences, and explosives technology.

Headquarters of the Stanford Research Institute are in Menlo Park, Calif. The institute was founded in 1946. Critically reviewed by the STANFORD RESEARCH INSTITUTE

STANFORD UNIVERSITY is a coeducational, privately controlled university in Stanford, Calif., 30 miles (48 kilometers) southeast of San Francisco. In 1885, Leland and Jane Lathrop Stanford founded the school

in memory of their son, Leland Stanford, Jr. The legal name is Leland Stanford Junior University. Stanford University was opened to students in 1891.

Stanford has schools of business, earth sciences, education, engineering, humanities and sciences, law, and medicine. It also has a food research institute, and study centers in England, France, Germany, Italy, Japan, and Taiwan. The university grants bachelor's, master's, and doctor's degrees.

The Hopkins Marine Station, at Pacific Grove, specializes in marine biology. The School of Medicine carries on advanced and clinical work. The university has many libraries, including the Hoover Institution on War, Revolution, and Peace. For the enrollment of Stanford University, see UNIVERSITIES AND COLLEGES (table). PETER C. ALLEN

See also CALIFORNIA (picture); LIBRARY (picture).

STANHOPE, PHILIP D. See CHESTERFIELD, EARL OF.

STANISLAS, *STAN is lus*, **SAINT** (1030-1079), is the patron saint of Poland and the city of Kraków, where he served as bishop. He became a saint of the Roman Catholic Church in 1253, and is honored as a martyr. His name is also spelled STANISLAUS.

Saint Stanislas was born at Szczepanowski, Poland. As a priest he took charge of a parish near Kraków. He was named bishop of Kraków by Pope Alexander II. His outspoken attacks against sin in both low and high places earned him the hatred of King Boleslav II of Poland. Boleslav ordered Stanislas killed. The king accompanied the guards who had been ordered to kill Stanislas. When the guards would not obey, the king killed the bishop himself. Saint Stanislas' feast day is celebrated on May 7. FULTON J. SHEEN

Stanford University is the home of the Hoover Institution on War, Revolution, and Peace. Scholars study a collection of historical materials assembled there to help the world strive for peace. The idea for such a collection came to Herbert Hoover while he was directing relief work in World War I.
Stanford University

STANISLAVSKI, KONSTANTIN (1863-1938), was the stage name of a well-known Russian director and actor. He tried to create truthful performances by having his actors study the inner lives of the characters as if they were real people. The actor's attempt to live the life of the character became known as the "Stanislavski method."

Konstantin Sergeyevich Alexeyev was born in Moscow. In 1898, with Vladimir Nemirovich-Danchenko, he established the Moscow Art Theater. The theater became famous for its realistic performances of plays by Chekhov, Gorki, and others. Stanislavski's direction of *The Sea Gull* in 1898 gave Chekhov his first success. Stanislavski's fame increased with his writings describing the methods he used in teaching actors and directing plays. His works include *An Actor Prepares* (in English, 1936) and *Building a Character* (in English, 1949). FREDERICK J. HUNTER

See also DRAMA (picture: Realism and Naturalism).

STANLEY is the family name of identical twin brothers who were inventors. They built the Stanley steam automobile. **Francis E. Stanley** (1849-1918) and **Freelan O. Stanley** (1849-1940) organized businesses and invented products together. They even cut their beards and dressed alike.

The Stanleys invented dry plate film and organized the Stanley Dry Plate Company in 1883. They sold out to Eastman Kodak in 1905. They experimented with steam engines, and in 1897 built the first Stanley steamer automobile (officially called the Stanley). They sold the car company to the Locomobile Company in 1899. But in 1902, they bought back their patents and organized the Stanley Motor Carriage Company. The Stanley brothers retired in 1917, and Francis was killed in an automobile accident in 1918. Freelan built a hotel in Estes Park, Colo., and lived there until he died in 1940. The Stanley brothers were born in Kingfield, Me. SMITH HEMPSTONE OLIVER

See also AUTOMOBILE (picture: The First Stanley Steamer).

STANLEY, FREDERICK A. See STANLEY OF PRESTON, BARON.

STANLEY, WENDELL MEREDITH (1904-1971), an American biochemist, did outstanding research on viruses. In 1935, he isolated the *tobacco mosaic virus* in crystalline form, and showed it to be a protein molecule. Before this discovery, scientists had assumed that viruses were submicroscopic living organisms. Stanley shared the 1946 Nobel prize for chemistry for preparing enzymes and virus proteins in pure form. He was born in Ridgeville, Ind. MORDECAI L. GABRIEL

STANLEY AND LIVINGSTONE, two famous British explorers, made the African continent known to the world. But they are probably known to most people for the search Stanley conducted to find Livingstone, and for Stanley's famous greeting when they met: "Dr. Livingstone, I presume?"

David Livingstone (1813-1873) received a degree in medicine from Glasgow University in 1840, and then became connected with the London Missionary Society. He went to South Africa to begin his missionary work. Livingstone wanted to convert the peoples of Africa to Christianity, to try to put a stop to the slave

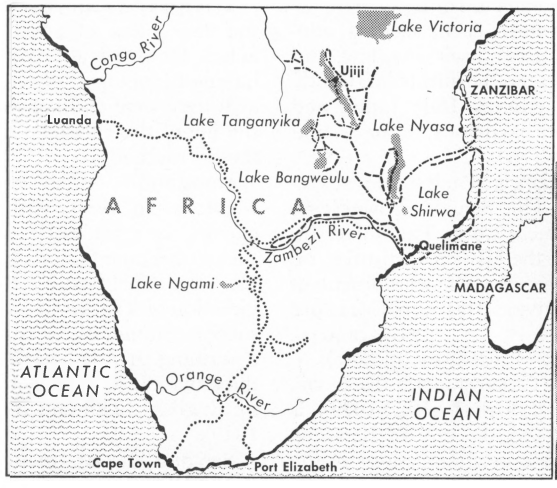
LIVINGSTONE'S EXPLORATION OF AFRICA

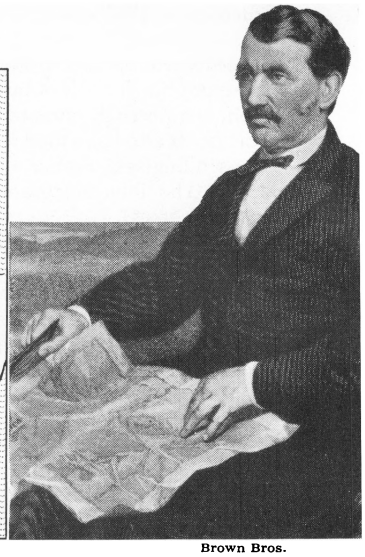
David Livingstone, *far right*, explored Africa and made the "Dark Continent" known to the world. The map of southern Africa, *right*, shows the routes he followed on his expeditions. Sir Henry M. Stanley, *below*, found Livingstone near Lake Tanganyika in 1871.

..... **Missionary Travels and 1st Expedition**

-.-.-. **2nd Expedition**

----- **3rd Expedition**





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trade, and to explore the mysterious African continent.

Livingstone began working in Bechuanaland (now Botswana) in 1841. He made a number of journeys into the interior of southern Africa, and arrived at Lake Ngami in 1849. He reached the Zambezi River in 1851, and began to explore it in 1852. He sighted the Victoria Falls on the Zambezi in 1855. In 1856, he returned to England.

In 1858, Livingstone returned to Africa as British Consul at Quelimane, Mozambique. He explored the Lake Nyasa region and the Shire River, and reached Lake Shirwa. He went to England again in 1864, but returned to Africa in 1866, and set out to find the source of the Nile River. He reached the southern end of Lake Tanganyika in 1867, and moved on into the interior of central Africa. Concern over his safety led to the expedition of Sir Henry Morton Stanley. Their names became forever linked as "Stanley and Livingstone."

Livingstone refused to return to the coast with Stanley in 1872, and continued his travels for another year. Weakened by illness, he arrived at Lake Bangweulu, which he had reached in July, 1868. There he died on April 30, 1873. Livingstone was later buried at Westminster Abbey in London. He was born at Blantyre, Scotland.

Sir Henry Morton Stanley (1841-1904) was born at Denbigh, Wales, and was baptized John Rowlands. His father died when the boy was two, and he spent most of his youth in a workhouse. At 18, he sailed as a cabin boy on a ship to New Orleans, La., where a merchant, Henry Morton Stanley, adopted him and gave him his name. When the Civil War began in 1861, Stanley joined the Confederate Army but was soon captured. He later joined the Union Navy. After the war, Stanley became a newspaper reporter, and, in 1869, the *New York Herald* sent him to find Livingstone.

In March, 1871, Stanley started his search from Zanzibar. After many hardships, he reached the town of Ujiji on Lake Tanganyika. There, in the autumn of 1871, he met Livingstone, who had been exploring the Lake Tanganyika region. After their meeting, Stanley gave Livingstone some supplies and stayed with him until March, 1872.

In 1874, Stanley heard of Livingstone's death and returned to Africa to carry on his work. In November, 1874, he left Zanzibar with three white men and more than 300 Africans. He pushed into the interior of Africa and sailed about Lake Victoria and other lakes. Then he started the dangerous trip down the Congo River from its source to its mouth. All his white companions and about 150 of the Africans died before he came to the Atlantic Coast in August, 1877.

The Congo region was rich in rubber and ivory, and Stanley tried to interest the British in the area. But he did not succeed and, instead, the Belgians colonized the region as the Congo Free State. Stanley led another expedition for the Belgians. In 1887, he made his last trip to Africa, to rescue Emin Pasha, who was cut off from civilization after an African uprising (see EMIN PASHA). Stanley then returned to Great Britain, where he became a naturalized citizen. He served in parliament until 1900. JAMES G. ALLEN

See also LAKE EDWARD; RUWENZORI RANGE.

STANLEY CUP is an ice-hockey trophy. Baron Stanley of Preston, a governor general of Canada, presented it in 1893. It goes to the National Hockey League playoff winner. For the winners of the Stanley Cup, see HOCKEY (table).

STANLEY FALLS is a group of seven cataracts on the middle part of the Congo River in Zaire. They drop about 200 feet (61 meters) in 60 miles (97 kilometers). They were named after Sir Henry Morton Stanley, the African explorer. To move river traffic around the falls, a railway runs from Kisangani to Ubundu, at the head of the falls. The hydroelectric potential of Stanley Falls has been estimated at between 7.5 million and 11.2 million kilowatts. WILLIAM A. HANCE

STANLEY OF PRESTON, BARON (1841-1908), FREDERICK ARTHUR STANLEY, a British statesman, received his first government appointment as lord of the admiralty under Prime Minister Benjamin Disraeli. He served as governor-general of Canada from 1888 to 1893. He gained popularity, and encouraged imperial sentiment. When he returned to England, he became a prominent figure in Liverpool, and was elected mayor. He became president of the British Empire League in 1904. Stanley was born in England. LUCIEN BRAULT

STANLEY POOL. See CONGO RIVER.

STANLEY STEAMER. See AUTOMOBILE (The First Automobiles [picture]); STANLEY (family).

STANOVOY MOUNTAINS, *STAN oh voy,* is a mountain range in Siberia. It extends for about 1,000 miles (1,600 kilometers) from the northern end of Lake Baykal northeast to the Sea of Okhotsk. Most of it is like a rugged plateau. The region is rich in minerals.

STANTON, EDWIN McMASTERS (1814-1869), was an American statesman. He served as secretary of war in President Abraham Lincoln's Cabinet, and later played an important part in the impeachment of President Andrew Johnson.

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Edwin M. Stanton

Stanton was born in Steubenville, Ohio, and was educated at Kenyon College. He studied law and was admitted to the bar in 1836. He practiced law in Pittsburgh from 1847 to 1856, and then moved to Washington, D.C., where much of his practice was before the Supreme Court. President James Buchanan appointed Stanton attorney general in 1860, and Lincoln made him secretary of war two years later.

Stanton was not popular in the war office, and Lincoln did not like him very well. Stanton was outspoken, and made many enemies. But he was an able manager, and gained a reputation for efficiency.

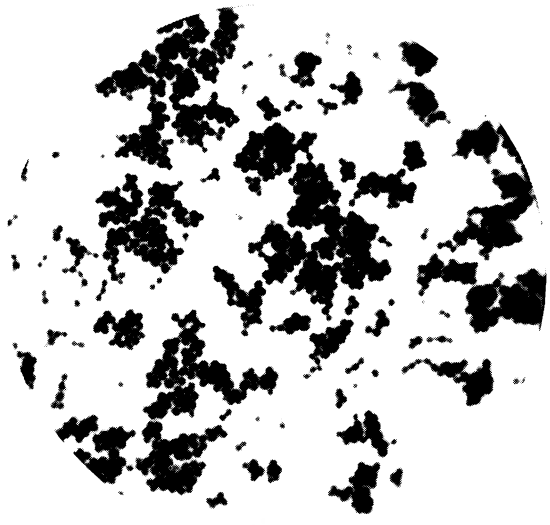
When Andrew Johnson became President, he and Stanton clashed repeatedly over the treatment of the South. Stanton cooperated with Johnson's enemies in Congress, and when Johnson removed Stanton from office, the House of Representatives impeached the President. Johnson was acquitted by one vote, and Stanton left office in May, 1868 (see JOHNSON, ANDREW [Increased Tension]). The next year, President Ulysses S. Grant appointed Stanton to the Supreme Court. But Stanton died four days later. W. B. HESSELTINE

See also TENURE OF OFFICE ACT.

STANTON, ELIZABETH CADY (1815-1902), advocated votes and equal rights before the law for women. In 1840 she married Henry B. Stanton, an abolitionist, and went with him to the World Anti-Slavery Convention in London. But women were not permitted to attend. In 1848, she and Lucretia Mott, another rejected delegate, called the first women's rights convention. Mrs. Stanton was the first president of the National Woman Suffrage Association, which she organized with Susan B. Anthony in 1869. She was born in Johnstown, N.Y. See also WOMAN SUFFRAGE. LOUIS FILLER

STAPES. See EAR (The Middle Ear).

STAPHYLOCOCCUS, *STAFF ih loh KAHK us,* is a common bacterium belonging to a group of round, or spherical, bacteria called *cocci.* Under a microscope, groups of these tiny organisms look like bunches of grapes. Staphylococci live in the air, in water, and on the bodies of human beings and animals. They cause boils and are responsible for a skin infection known as *impetigo.*



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Staphylococcal Bacteria grow in small clusters that look like bunches of grapes when seen through a powerful microscope.

Some staphylococci grow in foods and cause a type of food poisoning. Others cause pneumonia and blood poisoning. Because of differences in their growth habits, staphylococci have been separated into species and strains. Doctors may use antibiotics to treat diseases caused by staphylococci, but some strains have become resistant to these drugs. LOIS G. LOBB

See also ANTIBIOTIC; BACTERIA; BOIL; IMPETIGO; TOXIN.

STAPLE is a term used in the textile industry. It is applied to the qualities of a fiber or to its length. Cotton is often said to have good *staple.* This means that choice fiber can easily be worked into a certain size during spinning. The *staple length* for cotton is the average length of the bulk of its fibers. *Short-staple cotton* has fibers that average less than $1\frac{1}{8}$ inches (2.9 centimeters) in length. *Long-staple cotton* has fibers that average more than this length. See also COTTON (Classing).

STAPP is a unit of measure used in aviation medicine to express the combination of time and force that a pilot endures in rapid acceleration or deceleration. The force needed to pull a pilot out of a dive is measured in *G's* (see G). One stapp is the force exerted by one G acting on the human body for one second. Thus, a pilot who is exposed to three G's for 12 seconds is said to have endured 36 stapps. The stapp was named for John P. Stapp of the U.S. Air Force, who pioneered in aviation medicine experiments with rocket sleds.

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Like Gleaming Jewels, stars sparkle against the night sky. Some are surrounded by hazy clouds of dust. The telescope and camera that were used to make this picture caused circles and cross-shaped "rays" to appear around some stars. Astronomers call this group of stars *the Pleiades.* The inset on the opposite page shows how these stars look when seen without a telescope.

STAR

STAR is a huge ball of glowing gas in the sky. The sun is a star. It is the only star close enough to the earth to look like a ball. The other billions of stars are so far away that they are no more than pinpoints of light—if they can be seen at all.

There are more than 200 billion billion (200,000,000,000,000,000,000) stars. Suppose that everyone in the world were to count the stars. Each person could count more than 50 billion of them without the same star being counted twice.

Stars are the biggest things man knows of. The largest stars would more than fill the space between the earth and the sun. Such stars have a *diameter* (distance through the center) about 1,000 times as large as the sun's. The smallest stars are smaller than the earth.

We can hardly imagine the great distances that separate the stars. The star nearest the sun is more than 25 million million miles (40 million million kilometers) away from the sun. But even this great distance is only one-billionth the distance from the sun to the farthest stars known to man.

Stars differ greatly in color and brightness. Some stars look yellow, like the sun. Others have a bluish gleam or a reddish glow. A few stars twinkle brightly, but many are hard to see.

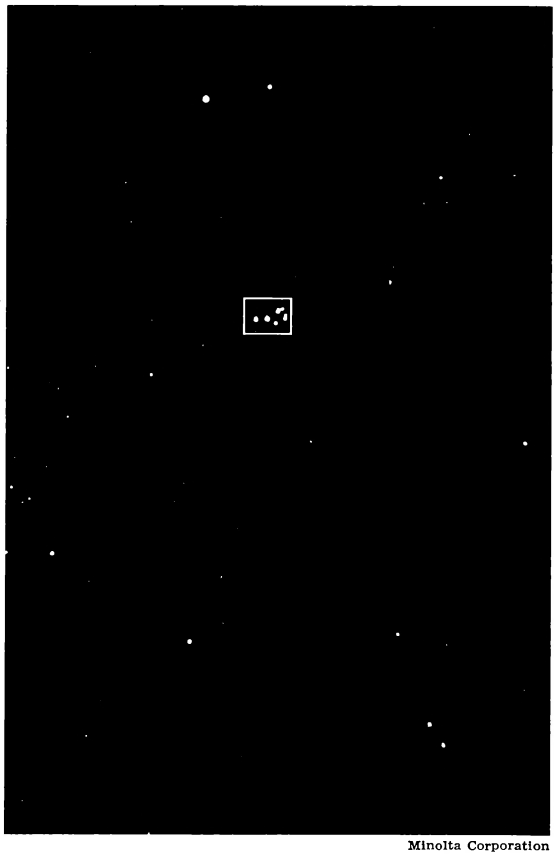
Stars twinkle because starlight comes to us through moving layers of air that surround the earth. The stars shine day and night, but we can see them only when the sky is dark and clear. During the day, sunlight brightens the sky and keeps us from seeing the stars.

At night, the stars seem to move across the sky—as the sun does during the day. This "movement" comes from the spinning of the earth, not from the movement of the stars. The stars themselves do move through space. But most of them are so far away from the earth that their movement cannot even be seen.

A star is made up mainly of two gases—hydrogen and helium. The star shines because atomic energy makes these gases very hot. The star continues to shine until it runs out of hydrogen gas, the fuel used to make the atomic energy. The star may then explode into a huge cloud of gas and dust.

Most stars began shining between 1 million and 10

Thornton Page, the contributor of this article, is Research Associate at the National Aeronautics and Space Administration's Lyndon B. Johnson Space Center and the author of several books on astronomy.



Minolta Corporation

The Stars of the Pleiades, shown in the above inset, appear in a closely spaced group. The ancient Greeks named these stars for the seven sisters of an ancient story. A stargazer without a telescope can easily see the six brightest stars of the Pleiades.

billion years ago. But new stars are still forming within the clouds of gas and dust left over from old stars. The sun itself was probably formed in this way from the remains of an old star. The earth took shape from the same material as the sun. Scientists believe that the earth—and all living things on it—is made up of atoms that once were part of a star.

Man has studied the stars since ancient times. Early farmers watched the stars to know when to plant their crops. Travelers learned to use the stars to tell directions. Ancient peoples made up stories about persons, animals, and other things they saw pictured in certain groups of stars called *constellations* (see CONSTELLATION).

The stars have long stood for man's hopes. The Star of David is a sign of the Jewish religion. The Star of Bethlehem recalls the birth of Jesus Christ. Stars appear on the flags of the United States and of many other countries. Top performers in motion pictures, television, the theater, and sports are called "stars."

Many starlike objects that we see in the sky are not stars. Some are planets. Meteors look like falling stars but are really pieces of rock or metal that burn up as they shoot through the air. For more information, see the WORLD BOOK articles on PLANET and METEOR.

STAR TERMS

Absolute Magnitude is a star's brightness if the star were 32.6 light-years from the earth.

Apparent Magnitude is a star's brightness as seen from the earth.

Binary Star is a pair of stars revolving around each other.

Black Dwarf is a shrunken star that does not shine because its energy-producing process has stopped.

Eclipsing Binary is a binary that revolves in such a way that one star periodically blocks the other's light.

Hertzsprung-Russell Diagram is a graph that shows the relationship between the absolute magnitude and spectral class of stars.

Light-Year is the distance light travels in one year—5,880,000,000,000 miles (9,460,000,000,000 kilometers).

Main Sequence, a band of points on the Hertzsprung-Russell diagram, represents the most common kinds of stars.

Neutron Star is a small star that may be made entirely of *neutrons* (one of the particles that make up atoms).

Nova is a star that explodes, becomes thousands of times brighter, and then becomes dim again.

Proper Motion is the change in a star's position among other stars. It is measured in terms of the angle that tells in which direction the star lies.

Spectral Class identifies a star's color and surface temperature.

Supernova is a star that explodes, becomes millions of times brighter, and then becomes dim again.

Variable Star is a star whose brightness changes.

White Dwarf is a small, white star with a large amount of material packed into an extremely small space.

STARS AT A GLANCE

Number: About 200 billion billion stars in the known universe.

Age: Up to 20 billion years. Most stars are between 1 million and 10 billion years old.

Composition: About 75 per cent hydrogen; 22 per cent helium; and traces of most other elements, including—in order of next highest percentages—oxygen, neon, carbon, and nitrogen.

Mass: From $\frac{1}{50}$ the mass of the sun to 50 times the mass of the sun.

Nearest Star Excluding the Sun: Proxima Centauri, 4.3 light-years away.

Farthest Stars: In galaxies billions of light-years away.

Brightest Star Excluding the Sun: Sirius (according to apparent magnitude).

Largest Stars: Have a diameter of about 1 billion miles (1.6 billion kilometers)—about 1,000 times that of the sun.

Smallest Known Star: Van Maanen's Star, with a diameter of 5,200 miles (8,370 kilometers).

Colors: From blue through white, yellow, and orange, to red, depending on the star's surface temperature.

Temperature: *Surface,* from about 50,000° F. (28,000° C) on blue stars to about 5000° F. (2800° C) on red stars; *interior,* more than 2,000,000° F. (1,100,000° C).

Radiations: Heat, light, radio waves, ultraviolet rays, X rays.

Energy Source: Nuclear fusion process and other processes that change hydrogen into helium and into energy.

Stars are not spread evenly throughout the universe. They appear in groups called *galaxies*. The sun and all the individual visible stars belong to a galaxy called the Milky Way. This galaxy has a shape like a pancake with a bulge in the center. The sun and the nine planets—including the earth—lie in the flat portion of the galaxy, a little more than halfway from the center to the edge.

How Many Stars Are There? No one knows exactly how many stars there are. Stars twinkle in every part of the sky, which can be thought of as "surrounding" the earth. On a clear, dark night, a person can see about 2,000 stars—but he sees only half the sky. A person on the opposite side of the earth could see another 2,000 stars if his half of the sky were dark. Thus, a total of about 4,000 stars can be seen. But these are just the brightest stars—the ones visible without a telescope.

A telescope brings many dim stars into view. For example, a total of about 600,000 stars can be seen through a telescope with a lens 3 inches (7.6 centimeters) in diameter. The largest telescopes make it possible to see about 3 billion individual stars and more than 1 billion galaxies. Astronomers believe these galaxies consist of a total of about 200 billion billion stars.

Only a few stars have names. Ancient stargazers named the brightest stars, such as Betelgeuse and Rigel in the constellation Orion. Today, astronomers use a letter of the Greek alphabet with the name of a constellation to identify a star. For example, Betelgeuse is called *Alpha Orionis* and Rigel is *Beta Orionis*.

The Size of Stars varies from dwarf stars that are smaller than the earth to giant stars far larger than the sun. The sun itself is a medium-sized star with a diameter of 865,000 miles (1,392,000 kilometers)—109 times that of the earth. Astronomers divide stars into four main groups by size: (1) supergiants, (2) giants, (3) medium-sized stars, and (4) dwarfs.

Supergiants, the largest known stars, include such stars as Antares and Betelgeuse. Antares has a diameter 330 times that of the sun. Betelgeuse actually expands and shrinks. Its diameter varies from 350 to 450 times that of the sun. The largest supergiants have diameters about a thousand times as large as the sun's.

Giants have diameters about 10 to 100 times as large as the sun's. The diameter of Aldebaran is 36 times as large as that of the sun. Capella's diameter measures 12 times that of the sun.

Medium-Sized Stars are about as large as the sun. Their diameters vary from about a tenth that of the sun to about 10 times the sun's diameter. Well-known stars in this group include Altair, Sirius, and Vega.

Dwarfs are the smallest stars. The smallest dwarf, van Maanen's Star, has a diameter of only 5,200 miles (8,370 kilometers)—less than the distance across the continent of Asia.

The Distance of Stars. The sun is about 93 million miles (150 million kilometers) from the earth. The star nearest the sun seems like only a pinpoint of light because it is about 25 million million miles (40 million million kilometers) from the earth. Astronomers call this star Proxima Centauri.

Astronomers measure the distance between stars in units called *light-years*. For example, Proxima Centauri is 4.3 light-years from the sun. A light-year equals 5.88 million million miles (9.46 million million kilometers). This is the distance light travels in one year at a speed of 186,282 miles (299,792 kilometers) per second. Some stars in the Milky Way are as far as 80,000 light-years from the sun and the earth.

The Milky Way's closest "neighbor" is a galaxy 200,000 light-years away. The most distant stars are billions of light-years away from the Milky Way. These stars make up other galaxies called *quasars*.

The sun belongs to a part of the Milky Way where the distance between stars averages 4 to 5 light-years. In some other parts of the Milky Way, the stars are much closer. In globular clusters, for example, less than one-hundredth of a light-year—about 60 billion miles (97 billion kilometers)—separates the stars.

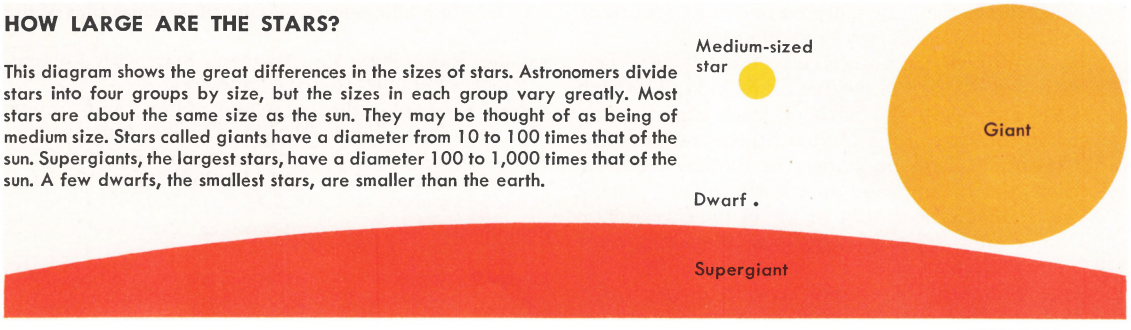
Why Stars Shine. A star's energy source lies deep within it. There, hydrogen gas changes into helium gas through a process called *nuclear fusion*. During this process, the amount of helium produced does not wholly equal the amount of hydrogen used up. Some of the material that makes up the original hydrogen changes into energy rather than into helium.

Nuclear fusion creates so much energy that the temperature at the center of the star reaches millions of degrees. From the surface of the star, the energy passes into space in such forms as light, heat, and radio waves. Stars shine until they use up all their hydrogen. Astronomers believe that most stars have enough hydrogen to last billions of years.

Color, Temperature, and Brightness. Starlight has a wide variety of color. Rigel sparkles with a blue light and Vega appears white. Capella's gleam looks yellow

HOW LARGE ARE THE STARS?

This diagram shows the great differences in the sizes of stars. Astronomers divide stars into four groups by size, but the sizes in each group vary greatly. Most stars are about the same size as the sun. They may be thought of as being of medium size. Stars called giants have a diameter from 10 to 100 times that of the sun. Supergiants, the largest stars, have a diameter 100 to 1,000 times that of the sun. A few dwarfs, the smallest stars, are smaller than the earth.

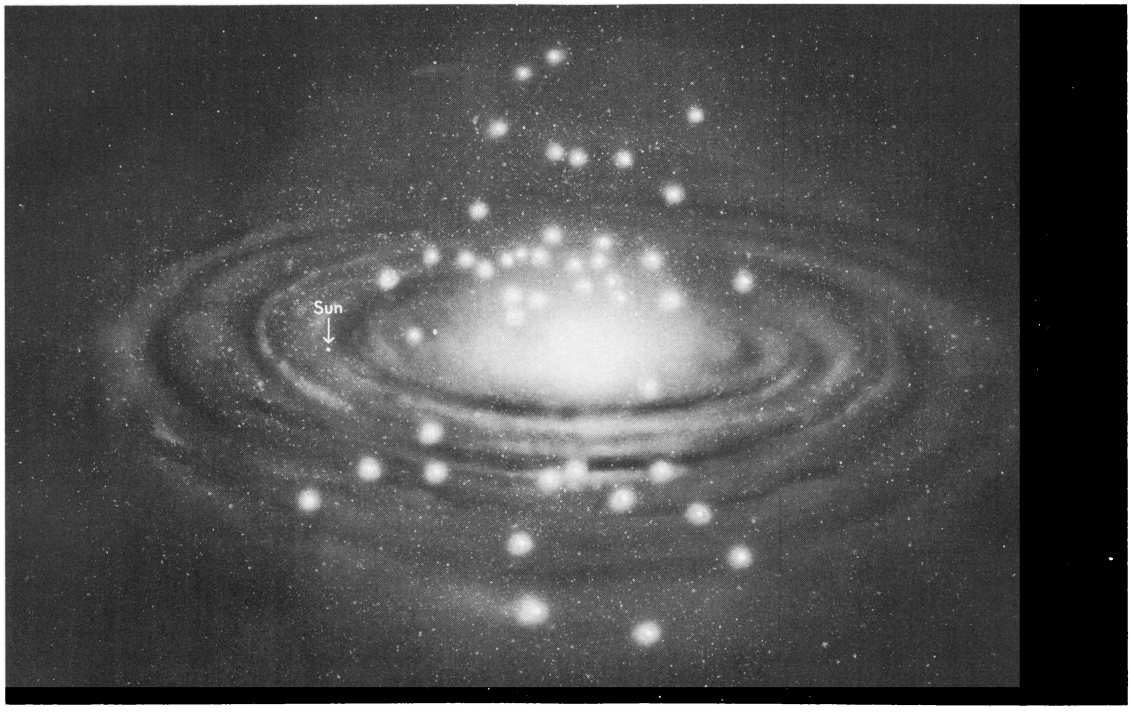


WORLD BOOK diagram

THE MILKY WAY GALAXY

The Milky Way is one of more than a billion groups of stars called *galaxies* that are found throughout the universe. Among the billions of stars in the Milky Way are the sun and its planets—including the earth. All the stars we can see without a telescope belong to this galaxy.

WORLD BOOK diagram by Herb Herrick



and Betelgeuse glows red. Other stars have in-between colors. They include blue-white Sirius and orange-red Arcturus.

A star's color indicates the temperature of its surface. This temperature varies from about 5000° F. (2800° C) for red stars, such as Betelgeuse, to about 50,000° F. (28,000° C) for blue stars, such as Rigel. Stars of other colors have surface temperatures somewhere in between. The sun, a yellowish star, has a temperature of about 10,000° F. (5500° C).

The brightest stars are not always the largest nor the nearest to the earth. Brightness also depends on the amount of light energy that a star sends out. Rigel is smaller and farther from the earth than is Betelgeuse. But Rigel sends out so much more light energy that it looks brighter than Betelgeuse.

Star Motions. Every day, the sun and all the other stars seem to move across the sky, rising in the east and setting in the west. The rising and setting comes from the spinning of the earth, not from the motion of the stars. See EARTH (How the Earth Moves).

Stars do move, but a star's motion produces only a slight change in its position among other stars. Astronomers measure this change—called *proper motion*—in terms of the angle that tells the direction in which the star lies. Barnard's Star has the greatest known proper motion. It takes 180 years for this star to move half a degree—an angle equal to the diameter of the moon as seen from the earth. The closer a star is to the earth, the easier it is for astronomers to measure its proper motion. However, most stars are so far away that their proper motion is too small to be measured.

The sun itself moves at a speed of 12 miles (19 kilometers) per second through the Milky Way. In addition, the sun and all the other stars of the Milky Way sweep around the center of the galaxy. This spinning motion of the galaxy gives the sun and the stars near it a speed of 170 miles (274 kilometers) per second.

Star Groups. The Milky Way has more than 100 billion stars. Many of these stars are in smaller groups called star clouds and star clusters. Pairs of stars are called double stars.

Star Clouds look like bright, hazy areas when seen without a telescope. The brightness comes from the millions of stars that make up these areas. Such clouds form a background against which astronomers can see dark clouds of *interstellar* (between-the-stars) dust.

Star Clusters may be either ball-like or of irregular shapes. Ball-like clusters, called *globular clusters*, consist of thousands of stars. About 100 globular clusters lie around the center of the Milky Way. Irregularly shaped clusters, called *open clusters*, have from 10 to a few hundred stars. These clusters lie within the main "pancake" of the Milky Way.

Double Stars, also called *binaries*, consist of a pair of stars. Many double stars belong to larger groups that include other double stars and single stars. Such groups are called *multiple stars*.

Measuring Direction and Position. Stars help mapmakers, pilots, and sailors find exact directions and locations. For example, the North Star serves as a guide to the direction north because this star always appears to be in the same place over the North Pole. The earth's spinning motion makes the sky seem to rotate. Observers north of the equator see the stars rotate around a point above the North Pole. The North Star is near this point and seems to move very little.

The North Star also can be used to measure latitude. An observer uses a sextant to measure the angle at which the star appears above the northern horizon. This angle is the same as the observer's latitude. For example, at 45° north latitude, the North Star is at an angle of 45° above the northern horizon.

Pilots and sailors measure their exact position by means of *celestial navigation*. This method depends on the idea that a star is directly over some point on the earth's surface at a given time. The earthly position of a star changes as the star appears to move from east to west. A book called an *almanac* lists the earthly positions of various stars at different times. To determine his position, the observer measures the angle of a star with a sextant and notes the exact time of the measurement. He then looks up the star's earthly position in an almanac. He uses the angle of the star to figure out how far his location is from the star's earthly position. By repeating the process with two more stars, he can find his exact location. See NAVIGATION.

Measuring Time. Man measures time in terms of the earth's two basic motions—(1) its spinning motion and (2) its movement around the sun. These motions of the earth cause changes in the position of the sun and of other stars.

The earth's spinning motion makes the sun and other stars appear to move across the sky each day. Ordinary clocks keep *solar time*—time based on the seeming movement of the sun. The period from one midnight to the next is called a *solar day*. Some astronomer's clocks keep *sidereal time*—time based on the seeming movement of the stars. A *sidereal day* is the time it takes for a star to reach the same position in the sky on two nights, one after the other. Because of the earth's motions, the stars seem to move slightly faster than does the sun. As a result, a sidereal day is slightly shorter than a solar day.

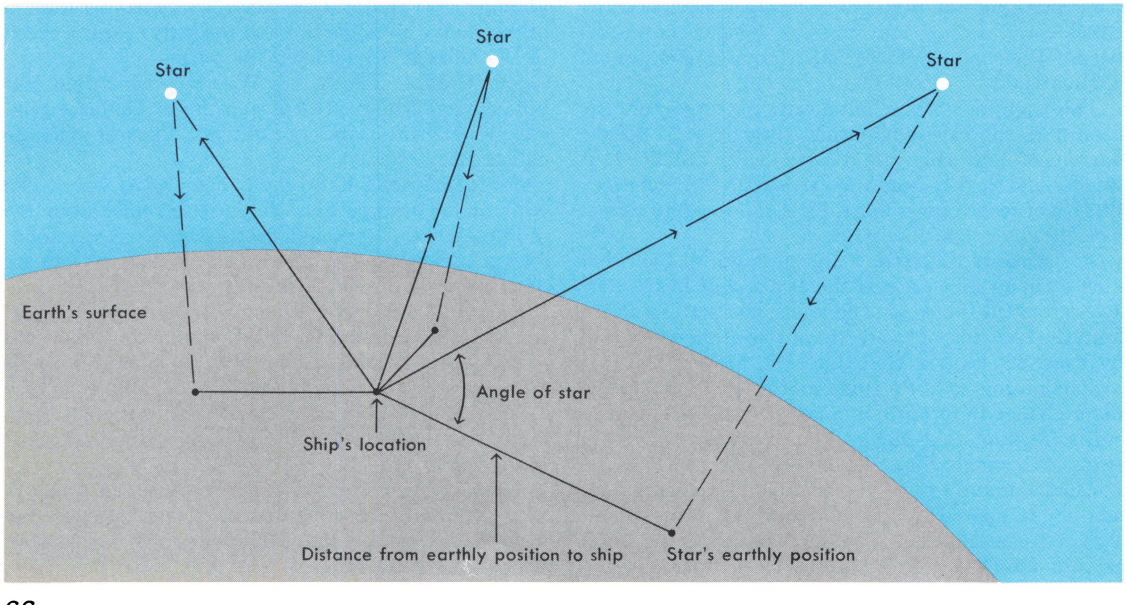
The earth's movement around the sun makes the sun change position against the background of the other stars during the year. Scientists measure the length of a *sidereal year* by measuring the time it takes for the sun to reach the same position among the stars. See SIDEREAL TIME.

Learning from the Stars. Understanding the stars helps scientists understand the laws of physics and chemistry. In the early 1900's—even before scientists knew enough about the atom to put it to work—astronomers believed that nuclear energy made stars shine. Today, astronomers seek to explain such mysteries as the high energy of quasars and the "beeping" radio waves from stars called *pulsars*. The answers to these mysteries may lead to a better understanding of the sun and of the earth itself.

HOW STARS HELP IN NAVIGATION

To find his ship's position, a sailor picks three stars and measures the angle that each makes with the horizon. He uses an almanac to find the earthly position associated with each of the stars at the time its angle was measured. He then calculates the distance of his ship from each of the three positions. His ship's location is the place on a map where the three distance lines meet.

WORLD BOOK diagram



Astronomers classify stars in several ways. For example, stars differ in brightness, color, and size. Stars classified according to these characteristics include main-sequence stars, giants and supergiants, and white dwarfs. Astronomers also group stars according to such features as variations in brightness, the presence of "companion" stars, and the release of radio waves, X rays, and other forms of energy. Stars grouped according to these features include variable stars and binary stars. Other stars and starlike objects give off such unusual radiations that astronomers have not yet completely explained them. Quasars and pulsars are in this mystery group.

Main-Sequence Stars are "ordinary" stars like the sun. They make up about 90 per cent of the stars that can be seen from the earth. They include stars of all star-colors and many degrees of brightness. Main-sequence stars have medium-sized diameters. They are so much smaller than giants and supergiants that they are sometimes called *main-sequence dwarfs*. However, they are much larger than white dwarfs.

Main-sequence stars have a common characteristic. If they were all the same distance from the earth, all stars of the same color would appear about equally bright. Blue stars would be the brightest, followed by white, yellow, and orange stars. Red stars would be the dimmest.

Astronomers use the term *luminosity* for the brightness of a star when viewed from a standard distance. Main-sequence stars get their name from a graph used by astronomers to study the luminosity of stars. Dots on the graph represent stars. The position of each dot indicates a particular star's combination of luminosity and color. The dots that stand for most known stars fall into a broad group. This group extends diagonally across the graph from the high-luminosity blue area to the low-luminosity red area. Astronomers call this grouping of dots the *main sequence*. For more information about the color-luminosity graph—known as the *Hertzsprung-Russell diagram*—see the section of this article called *Studying the Stars*.

Giants and Supergiants are larger than main-sequence stars and have a higher luminosity. They also differ in other characteristics, including the pressure and density of their gases (see DENSITY).

Some giants, such as Rigel, shine with a blue light, indicating their high temperature. A high pressure "squeezes" the gases that make up these blue giants. Such stars have a density higher than that of the sun and other main-sequence stars.

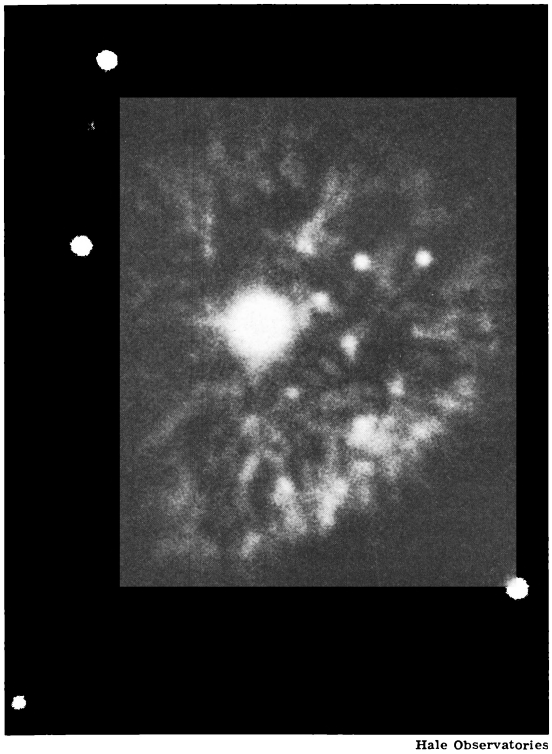
Other giants, such as Arcturus, have a red or reddish glow, indicating a low temperature. Red giants are somewhat larger than blue giants. They consist of gases under low pressure, with a density less than that of sunlike stars.

Such supergiants as Betelgeuse also shine with a low-temperature red color. The gases that make up a supergiant spread through so large a space that they may have a lower density than the air we breathe.

White Dwarfs are smaller than main-sequence stars and have a lower luminosity. They shine with a hot, white light. Astronomers believe that gravity within these stars has shrunk them to their small size. Gravity produces extremely high gas pressure and density in white dwarfs. These tiny stars are so dense that a spoonful of their gases would weigh tons if it could be weighed on the earth. White dwarfs include van Maanen's

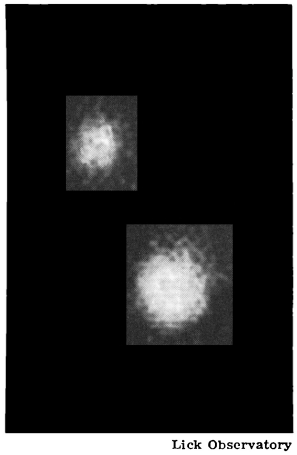
THE 20 BRIGHTEST STARS

Star	Distance (Light-Years)
1. Sirius	8.8
2. Canopus	98
3. Alpha Centauri	4.3
4. Arcturus	36
5. Vega	26
6. Capella	46
7. Rigel	900
8. Procyon	11
9. Betelgeuse	490
10. Achernar	114
11. Beta Centauri	290
12. Altair	16
13. Alpha Crucis	390
14. Aldebaran	68
15. Spica	300
16. Antares	250
17. Pollux	35
18. Fomalhaut	23
19. Deneb	1,630
20. Beta Crucis	490

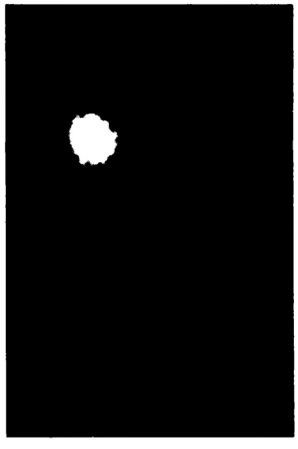


Hale Observatories

An Exploding Star in the constellation Perseus formed the cloud of gas shown above. The explosion's light was seen in 1901. The cloud, too small to be seen until 1916, is still expanding.



Lick Observatory



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The Home of a Pulsar. The Crab Nebula, *above*, is a large cloud of dust and gas. Deep within it, a pulsar sends out its "beeping" radio waves. The pictures at the right show the pulsar, which is located in the above inset. The pulsar's light varies from bright, *top*, to barely visible, *bottom*. This pulsar may be the remains of the star that exploded and produced the cloud.

Star—the smallest known star—and Sirius B—a companion star of Sirius.

Variable Stars shine brightly, then dimly, and then brightly again. There are three main types: (1) pulsating variables, (2) exploding stars, and (3) eclipsing binaries.

Pulsating Variables change in brightness as they expand and contract. The time it takes for such a star to change from bright to dim and back to bright again is called its *period*. Pulsating variables include short-period variables, long-period variables, and irregular variables. Short-period variables are yellow supergiants. Many of them pulsate about once a week. Astronomers also call them *Cepheid* variables because they discovered the first one in the constellation Cepheus. The North Star is a Cepheid variable with a period of about four days. Long-period variables are red giants or supergiants, such as Mira. Many of them have periods that last hundreds of days. Irregular variables do not have a regular period.

Exploding Stars burst unexpectedly with such energy that their light may become millions of times brighter. The extra brightness lasts for days or even years, and then the star returns to its dim appearance. Some stars explode again and again after indefinite periods. Astronomers call an exploding star a *nova*—the Latin word for *new*—because such outbursts were once thought to accompany the birth of a new star. The brightest novae are called *supernovae*. The most famous supernova exploded in the Milky Way in 1054 and produced a huge cloud of dust and gas called the Crab Nebula.

Eclipsing Binaries are double stars, such as Algol. They consist of a pair of stars that move around each other. The stars move in such a way that one periodically blocks the other's light. This blocking reduces the total brightness of the two stars as seen from the earth. Eclipsing binaries are only one kind of double star. The following section discusses other kinds.

Binary Stars consist of visual binaries and spectroscopic binaries. Either kind may also be an eclipsing binary.

Visual Binaries, when seen through a telescope, look like two stars revolving around each other. One revolution of these stars may take 100 years.

Spectroscopic Binaries look like single stars, even through a telescope. They are named for the *spectroscope*, an instrument that astronomers use to identify them. A spectroscope spreads starlight from a binary star into a *spectrum*, a band of colors similar to a rainbow. Certain features of the spectrum identify the light as

coming from a binary. Spectroscopic binaries complete their revolutions around each other in a few days or a few months.

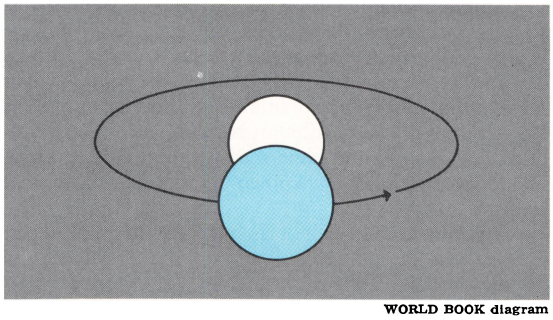
Well-known binaries include Mizar and Alcor, two of the stars in the handle of the Big Dipper. They form a double star that can be seen without a telescope. Through a telescope, Mizar also appears as a visual binary. In turn, both the stars that make up Mizar are spectroscopic binaries. Alcor is also a spectroscopic binary. Thus, Mizar's four stars and Alcor's two make up a total of six stars. Such groups of stars are called *multiple stars*.

Quasars and Mystery Stars. Some stars and starlike objects give off unusually strong radio waves and other kinds of radiation. Such starlike objects include quasars, pulsars, X-ray stars, and infrared stars.

Quasars send out strong radio waves. Astronomers believe they are not individual stars but small, extremely distant galaxies. See QUASAR.

Pulsars, like quasars, give off radio energy. But pulsars "beep," sending out a pulse of radio waves every second or so. Pulsars may be *neutron stars*—stars composed not of atoms but of neutrons, one of the main parts of an atom. A pulsar within the Crab Nebula is believed to be the remains of the star that exploded into a supernova in 1054. See PULSAR.

X-Ray Stars were discovered when scientists sent special telescopes above the atmosphere in rockets. Ordinarily, X rays from stars cannot be studied because they cannot get through the earth's atmosphere. The Crab Nebula sends out X rays as well as radio waves, but astronomers are not sure why.



WORLD BOOK diagram

An Eclipsing Binary consists of two stars that vary in total brightness as they revolve around each other. The brightness is greatest when all of both stars can be seen. It is lowest when one star is partially *eclipsed* (blocked) by the other, above.

Infrared Stars send out mainly heat. They probably have too low a temperature to give off such forms of energy as light and radio waves. These "stars" may really be interstellar clouds.

STAR / *How Stars Produce Energy*

Stars produce nuclear energy by changing hydrogen into helium. In a star, hydrogen changes into helium in two ways: (1) the proton-proton reaction and (2) the carbon cycle. Either way, some of the hydrogen ends up not as helium, but as energy that makes the star shine.

The energy-making process produces chemical by-products as well. It creates carbon, iron, oxygen, silicon, and other elements. The presence of these elements in stars helps scientists classify stars into age groups.

The Proton-Proton Reaction gets its name from the nucleus of a hydrogen atom. This nucleus consists of a single atomic particle called a *proton*. In the proton-proton reaction, nuclei of hydrogen atoms collide with one another and combine to produce nuclei of helium atoms.

The Carbon Cycle takes place in steps. First, nuclei of hydrogen atoms collide with carbon nuclei to form nuclei of nitrogen atoms. Then, additional collisions change the nitrogen to oxygen and back to nitrogen. Finally, each nitrogen nucleus breaks down into a carbon nucleus and a helium nucleus. The carbon nucleus then enters the cycle again.

Nuclear By-Products. Collisions between various kinds of nuclei during the nuclear energy-producing process create other elements. The star uses up its hydrogen and builds up its amounts of helium and other elements. Hydrogen and helium make up about 97 per cent of the mass of a star (see MASS). The remaining 3 per cent includes argon, carbon, chlorine, iron, magnesium, neon, nitrogen, oxygen, silicon, sulfur, and other elements.

Hydrogen and helium are the two "lightest" chemical elements. That is, their atoms have less mass than do the other elements. Atoms of such elements as carbon, nitrogen, and oxygen have more mass, and so they are considered "heavier." In a star, the heavier elements are created from the lighter ones during the nuclear energy-producing process.

Star Ages. The fact that stars create heavy elements from lighter ones helps astronomers distinguish between two "generations" of stars. Stars of the "younger" generation contain a larger amount of heavier elements than do stars of the "older" generation.

Many stars end their existence in explosions like the one that produced the Crab Nebula. Such an explosion creates a cloud containing the hydrogen, helium, and heavier elements that made up the former star. In time, the material in the cloud forms a new star. This new, second-generation star thus includes the remains of a star that was rich in the heavier elements. As a result, the new star contains a relatively high amount of those elements.

Astronomers call the younger-generation stars *Population I* stars. They call the older-generation stars *Population II* stars. Population I stars are relatively new stars, such as the sun. They were formed from gas that had been part of earlier stars. Population I stars contain larger amounts of the heavier elements than do Population II stars. Population II stars are older stars that were formed from the first gas clouds in space. These clouds consisted mainly of hydrogen and helium, with few, if any, heavy elements.

The life of a star lasts many billions of years. Most stars began shining between 1 million and 10 billion years ago. Some will keep shining for billions of years. Obviously, no one has ever watched a particular star take shape, change, and finally die. But astronomers have observed many different stars at various stages of their existence. They have also developed theories of star formation based on known chemical and physical laws.

Astronomers get much of their information about the life of a star by studying star clusters. The stars in a cluster probably formed about the same time, and thus are probably all about the same age. Some clusters include many blue giants, and such stars are believed to be young. Other clusters include many red giants that are thought to be old stars. From observation and theory, astronomers have put together the story of how stars probably begin and end their existence.

How Stars Form. A star begins its life as a cloud of interstellar gas and dust. Such clouds can be seen

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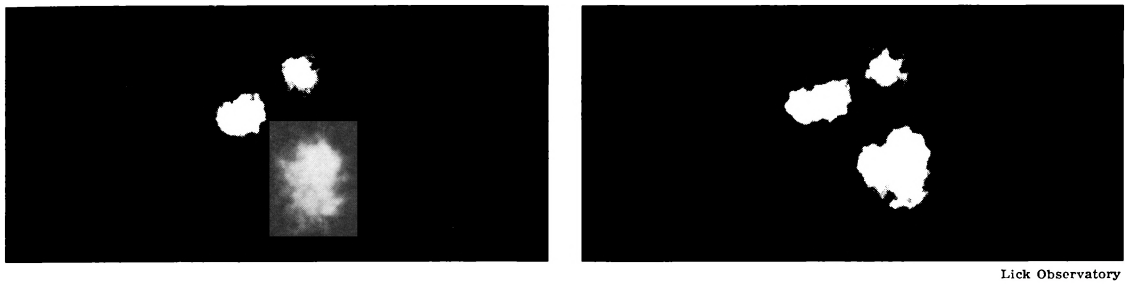
Stars in the Making. The huge cloud of interstellar dust and gas shown above reflects the light of nearby stars. Such bright clouds make it possible to see small, dark globs of material that are found between the cloud and the earth. Two such dark globs appear in the photograph above—at the upper right and upper left of the cloud. Such globs may be the beginnings of new stars.



Lick Observatory

Possible New Stars were discovered in a dust-and-gas cloud in the constellation Orion. A photograph taken in 1947, *left*, shows three stars in the cloud. A photograph taken in 1954, *right*, shows what astronomers believe may be two stars that came to life during the seven-year period. They are so close to two of the original stars that they form single enlarged images in the picture.

as dark patches in front of the bright, distant stars of the Milky Way. The cloud that is to become a star consists mostly of hydrogen mixed with dust. Astronomers believe some of the hydrogen and dust comes from old stars. The cloud may include the remains of a star that exploded, or it may be a collection of gases thrown from the surface of rotating stars.

The first step in the formation of a new star is the contraction of part of an interstellar cloud into a ball. Astronomers have never watched a new star flash into life. But they have discovered several dark, ball-like interstellar clouds that may be new stars beginning to take shape.

Through millions of years, the cloud of gas and dust contracts as gravity pulls it together. As the material pulls together into a ball, the pressure of the gas increases. The gas at the center of the ball becomes extremely hot. When the temperature at the center reaches about 2,000,000° F. (1,100,000° C), the nuclear fusion reaction begins. The hydrogen in the center begins to change into helium and to produce great amounts of nuclear energy. This energy heats the gas that surrounds the center. The gas begins to shine—and a star has come to life.

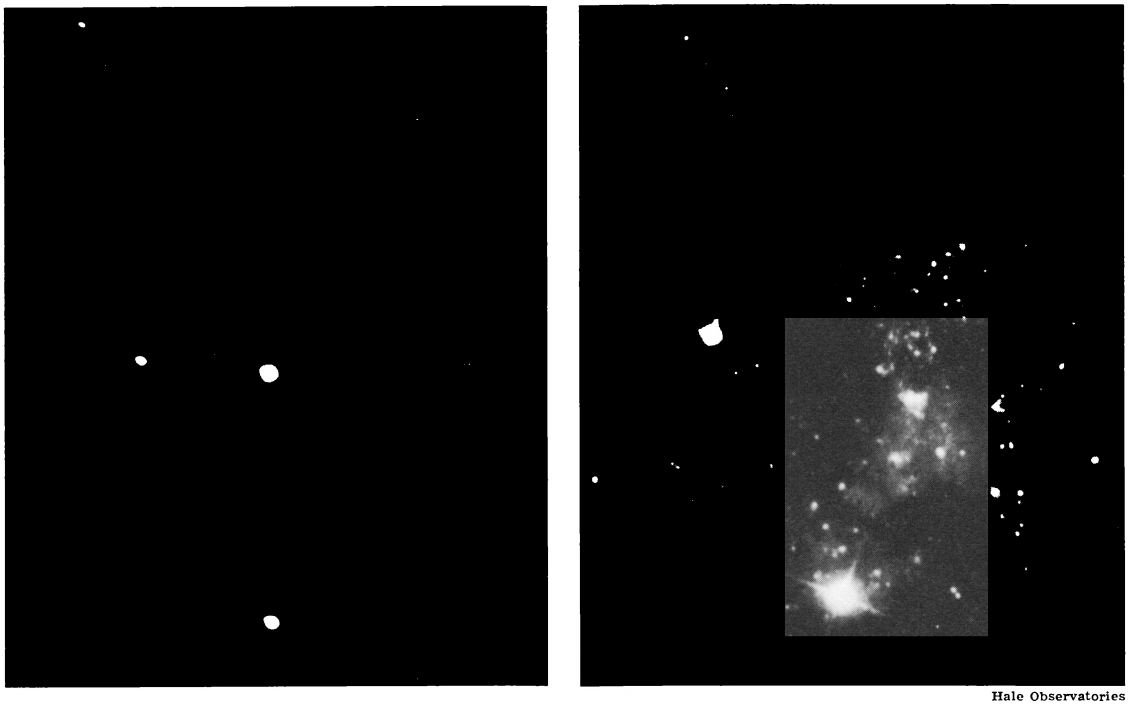
The kind of star that takes shape depends on the mass of the contracting cloud. A cloud with a mass about $\frac{1}{20}$ that of the sun becomes a red, low-luminosity main-sequence star. A cloud with a mass about 50 times that of the sun becomes a blue, high-luminosity, main-sequence star.

How Stars Change and Die. After a star begins to shine, it starts to change slowly. The speed with which it changes depends on how rapidly the nuclear energy-producing process takes place inside it. The speed of this process, in turn, depends on the mass of the star. The greater a star's mass, the higher its luminosity and temperature—and the faster it changes. Stars with a mass about 10 times that of the sun take a few million years to change. Smaller stars with a mass about $\frac{1}{10}$ that of the sun take hundreds of billions of years to change.

A star changes because its supply of hydrogen decreases. The center of the star contracts, and the temperature and pressure at the center rise. At the same time, the temperature of the outer part of the star gradually drops. The star expands greatly and becomes a red giant.

In time, the red giant begins to lose material from its surface. The force of gravity in the star overcomes the pressure in the star's core, and the star begins to collapse. The star shrinks, and its pressure and temperature increase. During this stage, the star may explode into a supernova. The star may eventually become a white dwarf, perhaps the last visible stage of a star.

When a star becomes a white dwarf, it may be only about the size of the earth, or smaller. The material that makes up a white dwarf is packed so tightly that the star cannot contract any further. The star may then slowly die out and become an invisible black dwarf—a cold, "burned out" star that no longer shines.



Hale Observatories

A Star Explodes and Dies in these photographs of a supernova and its remains. The photograph at the left shows the exploding star, *center*, at its greatest brightness. The photograph at the right, taken five years later, shows a cloud of gas in the area—but no star.

Astronomers study two main characteristics of starlight—brightness and color. Brightness indicates how much mass the star has. Color indicates the temperature of the star's surface. From a star's brightness and color, astronomers can learn about other important features, such as its size and distance.

This section discusses some of the tools and methods that astronomers use to study stars. For additional information, see the articles on ASTRONOMY (Astronomers at Work) and TELESCOPE.

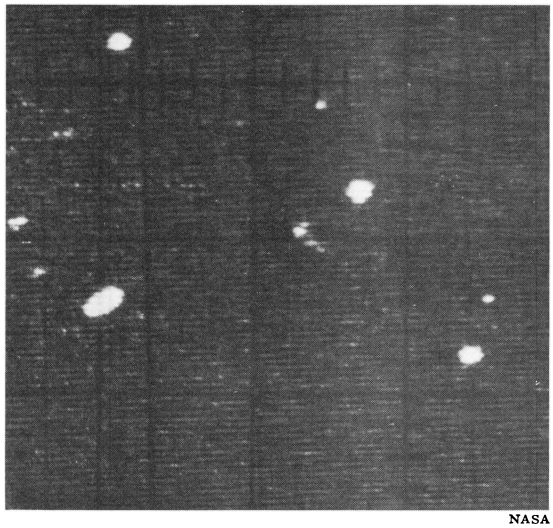
Measuring Brightness. Astronomers use an instrument called a *photometer* to measure the brightness of stars. They attach the instrument to a telescope. Light from a star enters the photometer and produces an electric current in it. An electrical meter indicates the star's brightness in terms of the strength of the current.

Astronomers compare the brightness of stars by using a number called the star's *magnitude*. The brighter a star is, the lower is its magnitude. A star with a magnitude of 1.00 is brighter than one with a magnitude of 2.00. The brightest stars have magnitudes so low they are less than zero—that is, they are expressed in negative numbers. Thus, a star with magnitude −1.00 is brighter than one of magnitude 1.00, but not so bright as one with a magnitude of −2.00. See MAGNITUDE.

A photometer measures the brightness of a star as it appears from the earth. Astronomers call this brightness the star's *apparent magnitude*. If astronomers know how far away a star is, they can calculate its *absolute magnitude*, which indicates the star's *luminosity* (actual brightness). Absolute magnitude is the brightness the star would appear to have if it were a standard distance —32.6 light-years—from the earth.

Measuring Color. Starlight is a combination of colors. The hottest stars give off more blue light than red light. Stars with lower surface temperatures give off more red light than blue light. Astronomers measure the intensity of a star's blue and red light by passing the light through color filters and then into a photometer. They use a blue filter to separate the blue light from the other colors. A red filter separates the red light. Astronomers also may measure a star's color with a *spectrograph*. This instrument takes a photograph of the star's spectrum. The photograph indicates how much light of each color is in the starlight.

Astronomers indicate the main color of a star with



NASA

Star Pictures Taken by Spacecraft are not affected by the earth's atmosphere, and so they contain information that telescopes on the earth cannot gather. The U.S. orbiting astronomical observatory took this picture high above the earth's atmosphere.

MILESTONES IN STAR STUDY

c. 3000 B.C. The earliest recorded astronomical observations were made in China.

c. 100's B.C. Hipparchus, a Greek astronomer, drew up the first catalog of stars that showed their brightness and position.

A.D. c. 150 Ptolemy, an astronomer in Egypt, cataloged more than 1,000 stars and developed a way of using numbers to record the positions of stars.

1572 Tycho Brahe, a Danish astronomer, proved that a supernova he observed was a star. He thus proved wrong an ancient idea that no change in the heavens could occur.

1609-1610 Galileo, an Italian scientist, pioneered the use of a telescope to study stars too faint to be seen with the unaided eye.

1718 Edmund Halley, an English astronomer, checked the positions of stars recorded by Hipparchus and found that some stars had moved. He thus showed that stars had a proper motion.

1780 Sir William Herschel, a British astronomer, made many discoveries about star brightness, binary stars, and clouds of interstellar gas and dust.

1783 John Goodricke, a British astronomer, correctly explained the varying brightness of Algol, the first known variable star, by suggesting that it was an eclipsing binary.

1838 Friedrich Bessel, a German astronomer and mathematician, became the first scientist to measure the distance of a star by parallax.

1850 The American astronomers William and George Bond, father and son, took the first telescopic star photograph.

1890's Edward Barnard, an American astronomer, proved that dark clouds of gas and dust exist among the stars of the Milky Way.

1910-1940 Henry Norris Russell, an American astronomer, pioneered in using the ideas of atomic physics to analyze the nature of stars.

1924 Sir Arthur Eddington, a British astronomer, explained the relationship between the mass and brightness of a star, a key idea in understanding the changing form of stars.

1948 The Australian astronomers John G. Bolton and Gordon J. Stanley discovered the first *radio star*, an invisible star that sends out strong radio waves.

1960 American astronomers at the Palomar Observatory discovered the first *quasar*—a small, distant galaxy—at a spot in the sky known to be a source of strong radio waves.

1967 British radio astronomers discovered the first *pulsar*, an object that sends out strong pulsating radio waves.

1969 American astronomers observed flashing light waves and X rays from a pulsar.

one of the following letters: O, B, A, F, G, K, or M. Each letter represents a color group called a *spectral class*. For example, blue stars fall into the "O" spectral class, yellow stars are "G" stars, and red stars are classified "M". The colors and temperatures associated with the spectral classes appear on the Hertzsprung-Russell diagram shown in this section.

The Hertzsprung-Russell (H-R) Diagram illustrates the relationship between star luminosity and spectral class. The diagram was named for the Danish astronomer Ejnar Hertzsprung and the American astronomer Henry Norris Russell. These scientists independently developed the idea for the diagram in the early 1900's. The Hertzsprung-Russell diagram is a graph with absolute magnitude shown vertically and spectral class horizontally. Each point on the graph represents the absolute magnitude and spectral class of a particular star.

The outstanding feature of the diagram is that the points representing most stars fall close to a diagonal line. For example, most blue stars have a high luminosity, most yellow stars a medium luminosity, and most red stars a low luminosity. Astronomers call this group of points on the diagram the *main sequence*.

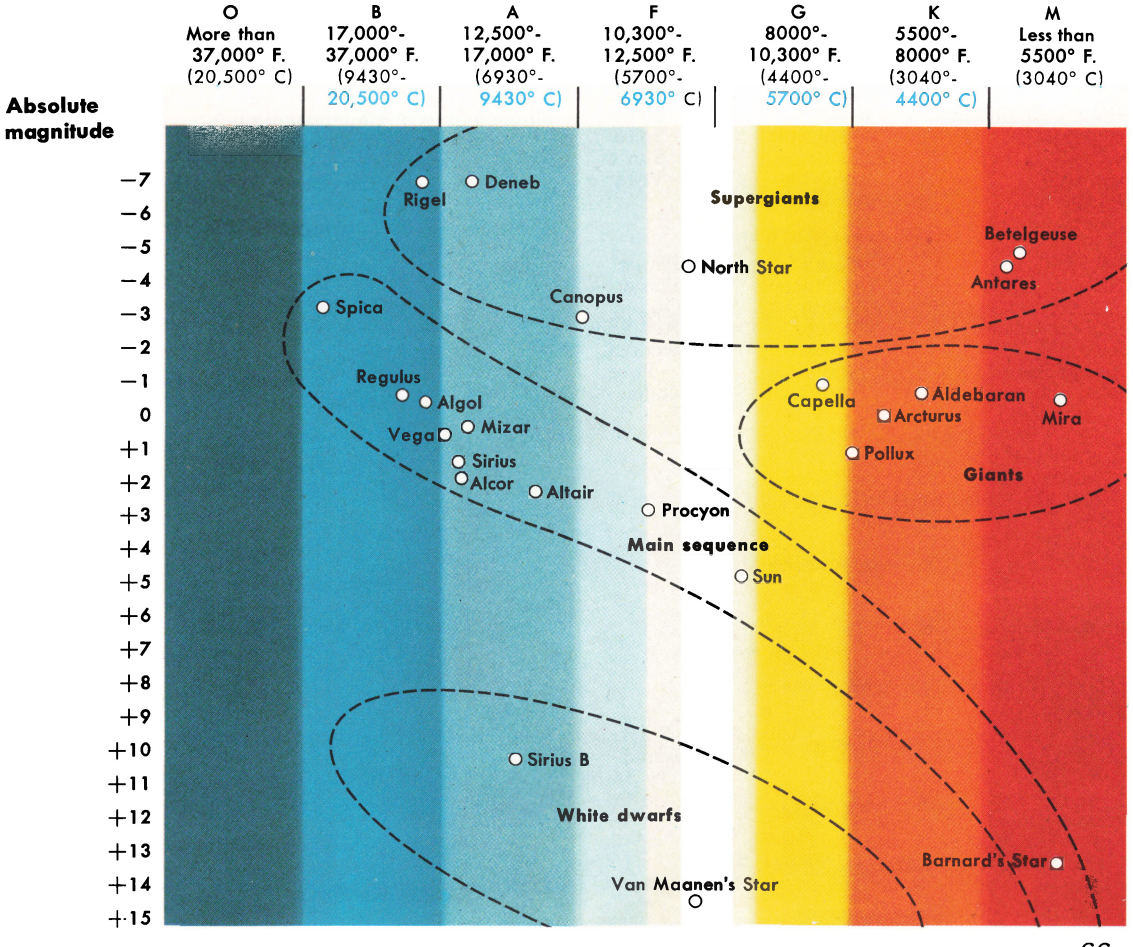
The H-R diagram also identifies other kinds of stars. Some red stars have an unusually high luminosity. These are the red giants and supergiants whose high luminosity comes from their tremendous size. Some white stars are much less luminous than white main-sequence stars. These are white dwarfs, which are much smaller than main-sequence stars.

Star Size and Distance. Astronomers have measured the sun's diameter and they have obtained fairly good measurements of the size of a few other stars. These stars are large and relatively close to the earth. But all the other stars are too far away to measure directly. Astronomers calculate the size of these stars from meas-

THE HERTZSPRUNG-RUSSELL DIAGRAM

This diagram helps astronomers classify and study stars. The color bands illustrate spectral classes identified by the letters and temperatures across the top of the diagram. A star is represented on the diagram by a dot located (1) horizontally according to the star's spectral class and (2) vertically according to its absolute magnitude. For example, the sun belongs to spectral class G and has an absolute magnitude of +5. This combination puts the sun on the main sequence.

WORLD BOOK diagram



urements of the star's luminosity and temperature.

Astronomers have measured the distance of about 1,000 nearby stars by using *parallax*. This method is based on the viewing of a star from two widely separated places. These places are opposite points along the earth's orbit around the sun. See PARALLAX.

Most stars are too far away for their distance to be measured by parallax. Astronomers measure the distance of such stars in terms of their luminosity by using the H-R diagram. For example, if the star is a main-sequence star, its position on the main sequence is determined according to its spectral type. The diagram indicates the luminosity that corresponds to this spectral type. Astronomers measure the star's spectral type. They then determine how far the star must be for its measured magnitude to agree with the luminosity indicated by the H-R diagram.

Unsolved Mysteries. Astronomers are working to improve their explanations of quasars, pulsars, and other kinds of mystery stars. They are investigating the effects of star rotation and the mixing of gases within stars. They also want to know more about the exact chemical composition of stars.

Today, astronomers can send instruments into space on rockets or with astronauts. These instruments can measure certain kinds of radiation that are either blocked by or changed by the atmosphere. Measurements made in space may help astronomers solve some star mysteries. They also may reveal new wonders to challenge the astronomer's imagination. THORNTON PAGE

STAR / *Study Aids*

Related Articles. See CONSTELLATION with its list of *Related Articles*. See also the following:

BIOGRAPHIES

Argelander, Friedrich W.
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Bessel, Friedrich W.
Bond (George P.)
Bowditch, Nathaniel
Cannon, Annie J.
De Sitter, Willem
Eddington, Sir Arthur S.
Galileo
Herschel (Sir William)
Hipparchus
Rittenhouse, David
Russell, Henry N.

STARS

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Algol
Alpha Centauri
Altair
Antares
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Planet
Pulsar
Quasar
Red Shift
Sidereal Time
Zodiac

Outline

I. Stars in the Universe
- A. How Many Stars Are There?
- B. The Size of Stars
- C. The Distance of Stars
- D. Why Stars Shine
- E. Color, Temperature, and Brightness
- F. Star Motions
- G. Star Groups

II. How Man Uses the Stars
- A. Measuring Direction and Position
- B. Measuring Time
- C. Learning from the Stars

III. Kinds of Stars
- A. Main-Sequence Stars
- B. Giants and Supergiants
- C. White Dwarfs
- D. Variable Stars
- E. Binary Stars
- F. Quasars and Mystery Stars

IV. How Stars Produce Energy
- A. The Proton-Proton Reaction
- B. The Carbon Cycle
- C. Nuclear By-Products
- D. Star Ages

V. The Birth and Death of a Star
- A. How Stars Form
- B. How Stars Change and Die

VI. Studying the Stars
- A. Measuring Brightness
- B. Measuring Color
- C. The Hertzsprung-Russell (H-R) Diagram
- D. Star Size and Distance
- E. Unsolved Mysteries

Questions

What process makes stars shine?
What two gases compose about 97 per cent of a star?
What do main-sequence stars have in common?
How long ago did most stars come into existence?
Which star has the largest known proper motion?
What is the difference between a star's apparent magnitude and its absolute magnitude?
What kind of star is so dense that a tiny amount of its material would weigh tons on the earth?
What are some interesting features of the Crab Nebula?
Which stars have a higher surface temperature, red stars or blue stars?
What are Population I stars? Population II stars?

Reading and Study Guide

For a *Reading and Study Guide on Stars*, see the RESEARCH GUIDE/INDEX, Volume 22.

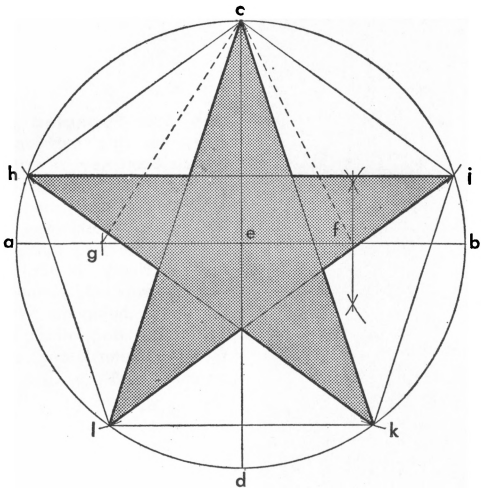
Books for Young Readers

BRANLEY, FRANKLYN M. *A Book of Stars for You*. Crowell, 1967.
JOSEPH, JOSEPH M., and LIPPINCOTT, SARAH L. *Point to the Stars*. 2nd ed. McGraw, 1972.
NEELY, HENRY M. *The Stars by Clock and Fist*. Rev. ed. Viking, 1972.
POLGREEN, JOHN and CATHY. *The Stars Tonight*. Harper, 1967.

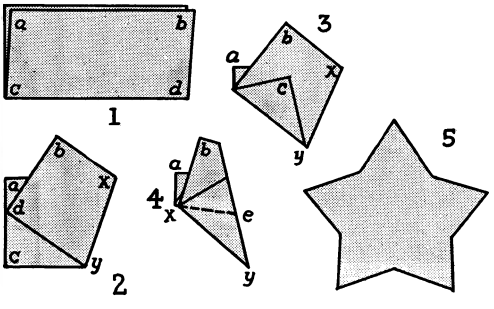
Books for Older Readers

BOVA, BEN. *In Quest of Quasars: An Introduction to Stars and Starlike Objects*. Macmillan, 1970.
CALDER, NIGEL. *Violent Universe: An Eyewitness Account of the New Astronomy*. Viking, 1970.
DIETZ, DAVID. *Stars and the Universe*. Random House, 1968.
KING, HENRY C. *Pictorial Guide to the Stars*. Crowell, 1967.
MOORE, PATRICK A. *Color Star Atlas*. Crown, 1973.
PAGE, THORNTON and LOU W., eds. *The Evolution of Stars: How They Form, Age, and Die*. Macmillan, 1968. *Beyond the Milky Way: Galaxies, Quasars, and the New Cosmology*. 1969.
REY, HANS A. *The Stars: A New Way to See Them*. Enlarged worldwide ed. Houghton, 1967.

STAR, FIVE-POINTED, is the star most widely pictured as a symbol and in art. The five-pointed stars in the Flag of the United States symbolize the Union of the states. Here are directions for drawing a five-pointed star, and for cutting it out of paper.



How to Draw a Star. This geometric drawing can be made by drawing a four-inch circle. Draw the horizontal and vertical diameter *ab* and *cd*. Mark the point of intersection *e*. Bisect *eb* and mark the point of intersection *f*. With *f* as a center, and *cf* as a radius, describe an arc cutting *ae*. Mark the point of intersection *g*. With *gc* as a radius and *c* as a center, describe two arcs cutting the circumference at *h* and *j*. With *h* and *j* as centers and the same radius, describe arcs cutting the circumference at *k* and *l*. Form a star by connecting *c* and *l*, *c* and *k*, *h* and *k*, *l* and *j*, and *h* and *j*.



How to Cut a Star. The drawings show how a star may be cut quickly by folding paper. Cut on the dotted line, *x* to *e*.

STAR ANISE. See ILLICIUM.

STAR CHAMBER was an English court of law during the 1500's and 1600's. It tried men too powerful to be brought before the ordinary, common-law courts. The Star Chamber consisted of men from the King's Council, a group of advisers to the king. It passed judgment without trial by jury.

The court was so named because it met in the Star Chamber of Westminster Palace. Today, the term *star chamber* refers to an unregulated, secret meeting of any court of justice or official body.

The Star Chamber was popular for a long time because it protected ordinary men from their oppressors. But eventually it abused its powers. Unlike the common-law courts, which protected the accused, it used torture to obtain confessions. King Charles I used the Star Chamber to crush opposition to his policies. In 1641, the Long Parliament abolished the court (see LONG PARLIAMENT). W. M. SOUTHGATE

STAR FINDER. See NAVIGATION (Instruments).

STAR GRASS is a flower with six starlike blossoms and yellow-green petals. Star grass grows in Kansas, Florida, and Texas, and from Maine to Ontario.

Scientific Classification. The common star grass belongs to the amaryllis family, *Amaryllidaceae*. It is genus *Hypoxis*, species *H. hirsuta*.

STAR MAPS. See ASTRONOMY.

STAR-OF-BETHLEHEM is a small, hardy plant that belongs to the lily family. It grew first in Italy, but now has become a common garden plant in America. Its flowers form the shape of a six-pointed star. The petal-like parts are white, but have green stripes on the outside.

J. Horace McFarland

The Star-of-Bethlehem Has Delicate White Flowers.

The leaves are green with white stripes. The flower stalk rises from a coated bulb.

People grow the star-of-Bethlehem in gardens, greenhouses, and window boxes. Its flowers bloom in May and June, and tend to close before nightfall.

Scientific Classification. The star-of-Bethlehem belongs to the lily family, *Liliaceae*. It is genus *Ornithogalum*, species *O. umbellatum*. ALFRED C. HOTTES

STAR OF DAVID. See DAVID, STAR OF.

STAR OF THE SOUTH. See DIAMOND (Famous Diamonds).

STAR ROUTE is a United States postal service. The postal transportation service of the United States Post Office Department makes contracts with agents to carry mail to post offices that are not served by railroads. The routes which these private agents cover are called *star routes*. The mail is usually carried in trucks. An incidental service on some star routes is the delivery and collection of mail in roadside mailboxes of families

The Star-Spangled Banner, the flag that inspired Francis Scott Key to write the national anthem, hangs in the Museum of History and Technology in Washington, D.C. Key saw the flag flying over Fort McHenry in Baltimore while he was held prisoner by the British during the War of 1812. The flag, which is 50 feet (15 meters) long, covers an entire wall.

D. Jordan Wilson, Pix from Publix

living along the star route. There are over 12,000 star routes. They have an average one-way length of a little over 22 miles (35 kilometers) a day. Star-route service is not the same as Rural Delivery, which is a direct service of the post office (see RURAL DELIVERY).

The term *star route* comes from the use of three stars, or asterisks, to indicate such a route. The stars replaced the words "Celerity, Certainty, and Security" which were used in Post Office Department records relating to the transportation of mails before 1859.

The development of highway transportation and reduction in railroad operations have brought an increase in star-route service in recent years. They have also resulted in a change from the "horse and buggy" type of transportation to trailer truck operations.

Critically reviewed by the U.S. POSTAL SERVICE

STAR-SPANGLED BANNER is the national anthem of the United States. It was written by Francis Scott Key and is sung to music composed by John Stafford Smith. In March, 1931, Congress officially approved the song as the national anthem. But the Army and Navy had recognized "The Star-Spangled Banner" as the national anthem long before Congress adopted it.

How the Song Came to Be Written. During the War of 1812, the British forces took prisoner William Beanes of Upper Marlborough, Md., and held him aboard a warship in Chesapeake Bay. Two Americans received permission from President James Madison to communicate with the British in an effort to have Beanes released. The men were Francis Scott Key, a lawyer, and John S. Skinner, both of Washington, D.C. Key and Skinner boarded the warship just as the vessel was preparing to bombard Fort McHenry, which protected the city of Baltimore. The British agreed to release Beanes. But they held all three Americans on a U.S. prisoner-exchange boat at the rear of the British fleet until after the battle ended, so they could not reveal plans of the attack to patriots on shore.

The bombardment started on Tuesday, Sept. 13, 1814, and continued all that day and almost all night. Key and his friends knew that Fort McHenry had little defense. The prisoners paced the deck all night. Even when dawn came, they did not know who had won the battle because the smoke and haze was so thick.

Suddenly, at 7 o'clock, a break in the mist cleared the view for a moment, and they saw the American flag still flying over the walls of the fort. Key was so excited that he wanted to express his feelings. He pulled an unfinished letter from his pocket and started writing verses. He wrote most of the words of the song in a few

Oh! say, can you see, by the dawn's early light,
What so proudly we hailed at the twilight's last gleaming?
Whose broad stripes and bright stars, thro' the perilous fight,
O'er the ramparts we watched were so gallantly streaming?
And the rockets' red glare, the bombs bursting in air,
Gave proof thro' the night that our flag was still there.
Oh! say, does that star-spangled banner yet wave
O'er the land of the free and the home of the brave?

On the shore, dimly seen thro' the mist of the deep,
Where the foe's haughty host in dread silence reposes,
What is that which the breeze, o'er the towering steep,
As it fitfully blows, half conceals, half discloses?
Now it catches the gleam of the morning's first beam,
In full glory reflected, now shines on the stream.
'Tis the star-spangled banner. Oh! long may it wave
O'er the land of the free and the home of the brave!

And where is that band who so vauntingly swore
That the havoc of war and the battle's confusion
A home and a country should leave us no more?
Their blood has washed out their foul footstep's pollution.
No refuge could save the hireling and slave
From the terror of flight or the gloom of the grave,
And the star-spangled banner in triumph doth wave
O'er the land of the free and the home of the brave.

Oh! thus be it ever when freemen shall stand
Between their loved home and the war's desolation,
Blest with vict'ry and peace, may the Heav'n-rescued land
Praise the Pow'r that hath made and preserved us a nation.
Then conquer we must, when our cause it is just,
And this be our motto, "In God is our trust."
And the star-spangled banner in triumph shall wave
O'er the land of the free and the home of the brave.

---

minutes. Later that day, the British released the Americans, and Key returned to Baltimore, where he finished the other stanzas.

How the Song Became Famous. The poem was printed on handbills the next morning and distributed in the city. A few days later, actor Ferdinand Durang sang "The Star-Spangled Banner" in Baltimore to the tune of an old English drinking song called "To Anacreon in Heaven." Americans knew the melody as that of a military march of the 1700's, and as a political song named "Adams and Liberty." Durang's performance marked the first time the anthem was sung in public. It became popular immediately, and three months later it was played during the Battle of New Orleans.

By government permission, the United States flag flies continuously over Key's grave at Frederick, Md., and over Fort McHenry. RAYMOND KENDALL

See also ANACREON; CONGREVE, SIR WILLIAM; FLAG (Saluting the Flag); KEY, FRANCIS SCOTT.

STARBOARD. See SHIP (Nautical Terms).

STARBUCK ISLAND is an uninhabited coral island in the South Pacific Ocean. It covers about 1 square mile (2.6 square kilometers). Starbuck Island was once an important source of guano, which is used for fertilizer. However, the guano deposits have been depleted. The island was discovered in 1823. Britain maintains a beacon there to guide ships. Both the United States and Great Britain claim Starbuck. For location, see PACIFIC ISLANDS (map). NEAL M. BOWERS

See also LINE ISLANDS.

STARCH is a white, powdery substance found in the living cells of green plants. It can be found in the seeds of corn, wheat, rice, and beans and in the stems, roots, and *tubers* (underground stems) of the potato, arrowroot or *cassava* (tapioca) plants. Starch is a carbohydrate, one of the most important foods. Starchy foods are an important source of energy for man and animals. When starch is digested in the body, energy is directly obtained from it.

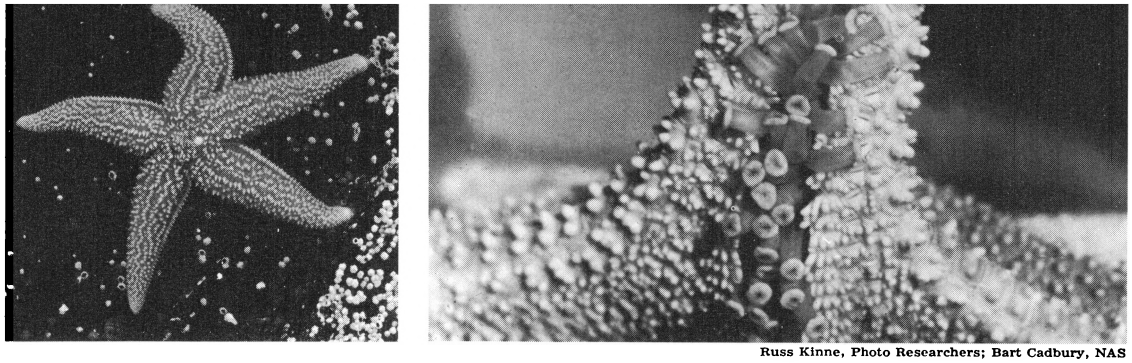
During *photosynthesis* (the food-making process) in green plants, the energy of sunlight changes water and carbon dioxide into glucose and oxygen. Plant cells can quickly convert glucose into starch. Tiny starch *granules* (grains) are formed in most green leaves during the day. At night, the starch is converted back to sugars, which then move to the root, stem, seeds, fruit, and other parts of the plant. The sugar may be used for growth, or stored again as starch.

Use in Foods. Starch or flour that contains starch are often used in cooking to thicken mixtures. The mixtures usually become pasty or jellylike. When starchy foods such as rice or macaroni are cooked, the starch granules swell and absorb water. Starch does not dissolve in water. Cooked starch is easily broken down in the body by digestive *enzymes* (chemicals). But uncooked starch is too insoluble to be digested easily.

During the cooking of some foods, the starch may change into other substances. For example, slightly scorched starch becomes *dextrin*, a sticky carbohydrate that is used as glue on stamps and envelopes. During bread making a small amount of starch becomes the sugar *maltose*. Maltose is fermented by yeast and changed into carbon dioxide and alcohol. The carbon dioxide forms bubbles in the dough and makes it rise.

Chemists use iodine to test for the presence of starch in food. When a small amount of iodine is added to a starch solution, it becomes blue-black. Under the microscope, starch appears as tiny granules. Cornstarch granules are rounded, irregular *polygons* (many-sided) about 10 to 20 microns in diameter. Potato starch granules are oval with *concentric* (common center) rings and may be more than 100 microns in diameter. Rice starch has tiny granules about 3 to 5 microns in diameter. With experience, a person can identify a certain kind of starch by the way it looks under a microscope.

Industrial Uses. Industry manufactures over 5 billion pounds (2.3 billion kilograms) of starch in the United States each year. About half of it is sold as starch and dextrin, and $1\frac{1}{2}$ billion pounds (0.7 billion kilograms) are converted into starch syrup. Most of the starch is used to *size* (stiffen) weaving yarn and to finish the cloth. Starch gives high-quality paper strength and a smooth, glossy finish. Starches are also used in making paste-



Russ Kinne, Photo Researchers; Bart Cadbury, NAS

Most Starfish Have Five Arms, *above left,* although some kinds have as many as 50 arms. There are many tube feet on the underside of each arm, *above right.* Each of the tube feet has a tiny suction disk at its tip. The starfish uses its tube feet and suction disks to crawl over the seabed.

board, corrugated board, plywood, and wallboard. A starch called *Amioca* is produced from *waxy maize* (a kind of corn). Amioca produces pastes that are clear and fluid, unlike cornstarch.

To manufacture cornstarch, corn is soaked in warm water and sulfur dioxide for two days. The softened kernels are torn apart and the *germ* (part of the inside) is removed. The kernel fragments are then ground and *screened* (sifted) down to starch and *gluten* (proteins). The starch is then filtered, washed, dried, and packaged. Similar processes are used for starch from waxy maize and sorghum.

To make potato starch, the potatoes are washed and ground, and the starch is separated from potato fibers by screening. After further separation, the starch is washed and dried. Arrowroot and tapioca starch may be produced by similar methods.

Wheat starch can be manufactured by *kneading* (mixing) wheat flour into a dough. The starch is washed out of the sticky mass by a stream of water. Rice starch is made by soaking the grain in an alkaline chemical, which dissolves the gluten but not the starch. The starch is then separated and washed. DEXTER FRENCH

Related Articles in WORLD BOOK include:

Arrowroot	Cornstarch	Sago
Carbohydrate	Dextrin	Tapioca
Cellulose		

STARFISH, or SEA STAR, is a sea animal that has arm-like extensions on its body. Most *species* (kinds) have five "arms" and look somewhat like five-pointed stars. However, not all starfish look like stars. Some have such short arms that their body looks like a *pentagon* (five-sided shape). Others have many arms. They are called *sun stars* because their shape resembles the sun and its rays.

Starfish live in all of the world's oceans. But they are not fish. They are members of a group of animals called *echinoderms.* The echinoderm group also includes the brittle star, sea cucumber, sea lily, and sea urchin. See ECHINODERM.

The starfish body has a *central disk* and *arms.* Its mouth, in the middle of the underside of the central disk, leads directly into a large, baglike stomach. On the outside of the body, a groove extends from the mouth to the tip of each arm. Rows of slender tubes, called *tube feet,* line these grooves. The animal uses the suction disk at the end of each tube foot for crawling. These disks grip hard surfaces. The starfish "sees" with a small colored *eyespot* located at the tip of each arm. The eyespot senses light, but cannot form images. The starfish uses its tube feet and a tiny, sensitive *tentacle* located at the tip of each arm to "feel."

Starfish release eggs into the sea through small holes between their arms. The eggs form into tiny swimming larvae. After a while, each larva settles down on the sea bottom and develops into a starfish. Starfish can *regenerate* (grow again) new arms when the old ones are broken off. Even if a starfish is cut in two, each of the pieces will regenerate into a new animal. Most starfish live for three to five years, but some may live as long as seven years.

Many starfish feed on shelled animals such as mussels, clams, and oysters. The starfish can push its stomach out through its mouth. When it feeds on an oyster, it attaches its tube feet to the two halves of the oyster's shell and pulls the shell halves apart, opening a tiny crack between them. Then the starfish pushes its stomach, turned inside out, through the crack. A starfish can slide its stomach through a crack no larger than the thickness of a piece of cardboard. The stomach surrounds the oyster's soft body, slowly digests it, and absorbs the food into the starfish's body. Such starfish are serious pests in the oyster-breeding grounds of the eastern coast of the United States.

Scientific Classification. Starfish belong to the phylum *Echinodermata.* They are classified in the class *Asteroidea.* ROBERT D. BARNES

See also ANIMAL (pictures: Animals of the Oceans, How Animals Eat); CORAL (How Coral Is Formed).

STARK, JOHANNES (1874-1957), a German physicist, was noted for his discovery of the *Stark effect.* This discovery, the splitting of spectral lines when an emitting atom is in an electrical field, won for him the 1919 Nobel prize in physics. He also noted the change in frequency of light from moving atoms in a gas-discharge tube. This was the first observation of the optical *Doppler effect* from a source other than the stars (see RELATIVITY [General Relativity Theory]).

Stark was born at Schickenhof, Bavaria. He attended schools in Bayreuth and Regensburg. At the University of Munich, he studied physics, chemistry, mathematics, and crystallography. After graduation, he taught in technical high schools at Hannover and Aachen.

In 1917, Stark went as a professor of physics to the University of Greifswald. From there, he went as a professor to the University of Würzburg in 1920. He served as president of a technical institute in Charlottenburg from 1933 to 1939. CARL T. CHASE

STARK, JOHN (1728-1822), was a leading American general in the Revolutionary War. His crushing defeat of Colonel Friedrich Baum's raiding party of Germans, Tories, Canadians, and Indians near Bennington, Vt., on Aug. 16, 1777, was a turning point of the war. It was a severe setback to General John Burgoyne's campaign to cut the American colonies in half.

Stark's New Hampshire regiment defended the American left wing at Bunker Hill in 1775. He helped cover the 1776 retreat from Canada, commanded units at the battles of Trenton and Princeton, and served in the Rhode Island campaign of 1779. Stark was born in Londonderry, N.H. He served with Rogers' Rangers in the French and Indian War from 1754 to 1763. A statue of Stark represents New Hampshire in the U.S. Capitol in Washington, D.C. CLINTON ROSSITER

STARLING is a black songbird with pointed wings, a short tail, and a long, sharp bill. Its feathers have a greenish-purple or lilac gloss, and are tipped with buff during the winter. Starlings live in large flocks, sometimes even during the nesting season. The birds make nests in hollow trees, in birdhouses, or in holes in cliffs. The female starling lays from 4 to 6 light-blue eggs.

John Gerard

The Aggressive Starling often steals the nests of other birds for its home. The male has glossy black plumage.

The starling is helpful to farmers because it eats great numbers of harmful insects. But in the fruit season it is a pest because it also eats many berries, cherries, and even apples and pears. Starlings that roost in trees and on buildings are a nuisance to city-dwellers.

The starling came originally from the British Isles and other parts of Europe. In 1890, about 60 starlings were set free in Central Park in New York City. About 40 more were set free in 1891. Millions of starlings now live in the United States. The starlings in Norway and Sweden fly to Southern Europe when winter arrives.

Scientific Classification. Starlings are members of the starling family, *Sturnidae*. The starling of North America and much of Europe is classified as genus *Sturnus*, species *S. vulgaris*. ALBERT WOLFSON

See also BIRD (color picture: Birds' Eggs).

STARR, ELLEN. See HULL HOUSE.

STARR, RINGO. See BEATLES.

STARS AND BARS. See FLAG (color picture: Flags in American History [Confederate Flags]).

STARS AND STRIPES. See FLAG (Flags of the U.S.).

STARS AND STRIPES is the name of two unofficial daily newspapers of the U.S. Armed Forces. One is published in Europe, and the other is published in the Pacific area. They present news, editorials, and features of interest to servicemen stationed outside the United States. The newspapers' staffs consist of both civilian newspapermen and military personnel.

Stars and Stripes appeared briefly during the Civil War. In February, 1918, it began as a weekly newspaper, published in Paris by the American Expeditionary Forces serving in World War I. It ended publication in 1919, but reappeared in April, 1942, during World War II. *Stars and Stripes* became a daily newspaper in November, 1942, as the number of U.S. soldiers involved in the war increased. It was published in several places, including Honolulu, London, Manila, the Mediterranean area, the Middle East, Paris, and Tokyo. Cartoonist Bill Mauldin served on the European newspaper's staff during World War II and became famous for his portrayals of soldiers and war (see MAULDIN, BILL). Since World War II, the two *Stars and Stripes* have continued to serve soldiers stationed outside the United States. DAVID B. O'HARA

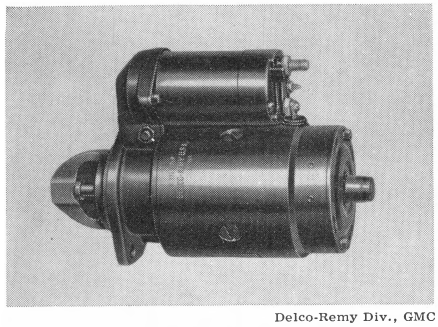
STARTER is a device that sets an engine in motion. Starters use various kinds of power, including human muscle, electricity, compressed air, and even exploding cartridges.

Automobile Starters. The gasoline engines in early automobiles had to be started with a crank. A driver had to pull or spin the crank to make the crankshaft revolve and start the engine. Cranking a car was hard work, especially in cold weather when the oil in the engine was stiff. The engine sometimes backfired and spun the hand crank in the wrong direction. This spin could break a man's arm.

Charles F. Kettering developed the first successful electric starter for automobiles. It was first installed in a Cadillac in February, 1911. The chief parts of this starter are the motor and the drive. When the driver turns on the ignition and presses the starter switch, a heavy current from the car's storage battery turns the starter motor. A drive shaft and gear connect the starter motor to the engine's flywheel. The crankshaft revolves, the pistons and rods go up and down, and the engine starts firing. An automatic device then disconnects the starter motor from the engine. Without this disconnecting device, the engine would turn the starter too fast and ruin it.

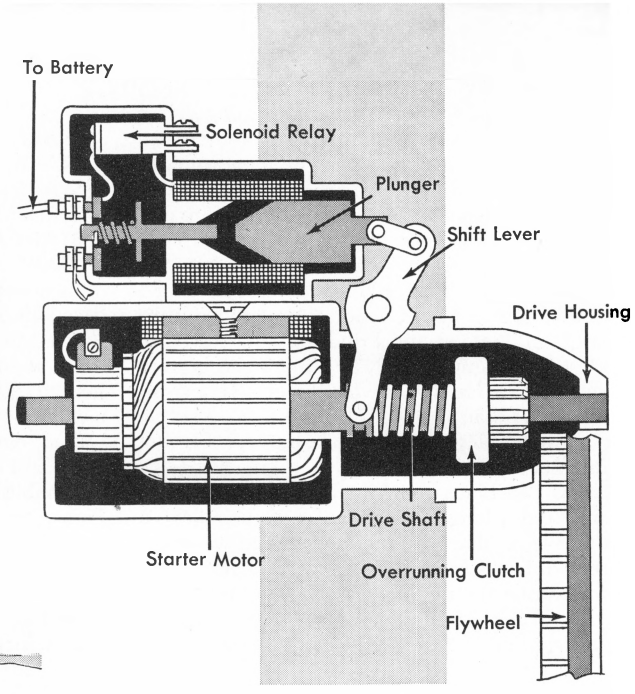
Diesel Starters. Diesel engines require more starting power than gasoline engines because they work at much higher compression. Some diesel engines use powerful electric starters similar to those for automobile gasoline engines. Railroad locomotive diesels use their generators as electric starters. Many diesels are started by pumping compressed air directly to some of the cylinders. The air drives the pistons until the engine fires of its own accord. A small auxiliary, or helper, engine starts other diesels.

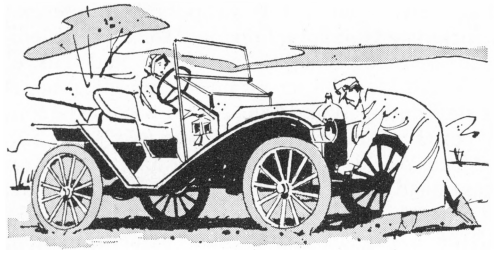
STARTER



Delco-Remy Div., GMC

Typical Starter





An Automobile Starter is an electric motor that receives its power from a battery. When a driver engages the starter, the relay connects the motor to the battery. The plunger moves the clutch into position with the engine's flywheel. The revolving starter shaft turns the flywheel, which turns over the engine. The starter then disconnects automatically.

Airplane Starters. Mechanics started the first airplanes by pulling the propeller by hand. Then aircraft engineers developed the *inertia starter*. This has a small flywheel that is set spinning by hand or by an electric motor. When gears engage this flywheel with the engine crankshaft, it turns the engine. Aircraft also use compressed-air starters, exploding cartridges, special hand cranks, and electric-motor starters. FRANKLIN M. RECK

See also DIESEL ENGINE; GASOLINE ENGINE.

STARVATION occurs when a living thing dies from lack of food or certain kinds of food. Most plants need water, sunlight, and chemicals from the soil. If any of these foods is removed, the plant eventually dies. Man needs minerals, vitamins, water, and foods such as carbohydrates, fats, and proteins. If he does not receive enough of each, his body wastes away, and he finally starves.

Man needs certain foods because his body cells do not work properly without them. Without food, a cell must use up its own parts to keep working. During its first few days without food, the body uses *glycogen* (also called animal starch) that has been kept in the liver as reserve food. But the main reserves of the body are fat and, later, muscle. As the time without food goes on, the vital cells become so weakened that death occurs.

If man has enough water, he can fast from 40 to 50 days without suffering permanent injury. He will drop to about half his normal weight during that period, however. EWALD E. SELKURT

See also FAST; NUTRITION.

STARVED ROCK STATE PARK. See LA SALLE, SIEUR DE.

STASSEN, HAROLD EDWARD (1907-), former governor of Minnesota, served as special assistant for disarmament to President Dwight D. Eisenhower from 1955 to 1958. He was a candidate for the Republican nomination for President in 1948 and 1952.

Stassen was born near St. Paul, Minn., and was graduated from the University of Minnesota. After serving as attorney of Dakota County, he was elected governor in 1938 and was re-elected twice. While governor, Stassen revised the civil-service laws and lowered the costs of state government. He supported a labor law that provided a "cooling-off" period before strikes. This brought him national recognition. Early in his third term, he resigned to serve in the Navy.

In 1945, Stassen became a delegate to the San Francisco Conference which founded the United Nations. He was appointed president of the University of Pennsylvania in 1948. Stassen resigned in 1953 to serve as mutual security administrator, and then as foreign operations administrator, a position which controlled American aid to many countries. Stassen resigned as special assistant for disarmament in 1958 to seek the nomination for governor of Pennsylvania, but lost. RICHARD L. WATSON, JR.

Harold Stassen
Rosenthal, Pix

STATE. See STATE GOVERNMENT; UNITED STATES; NATION.

STATE, DEPARTMENT OF, is the executive department of the United States government that handles U.S. relations with other governments. The head of the department is the *secretary of state*, the senior member of the President's Cabinet. The secretary and his department advise the President on foreign relations and provide him with information about conditions in other countries.

The department plans United States actions in dealing with other governments. When the President approves these plans, they become the official *foreign policy* of the United States. The department is responsible for carrying out foreign policy. It also coordinates the actions of other executive departments that affect foreign policy.

The department negotiates treaties and agreements with other governments; handles official business with foreign embassies in Washington; speaks for the United States in the United Nations and other international organizations; and arranges for U.S. participation in international conferences. The secretary of state is the official custodian of the Great Seal of the United States, which is affixed to all presidential proclamations (see GREAT SEAL OF THE UNITED STATES).

Members of the Foreign Service, the operating arm of the department in other countries, represent the United States throughout the world. They deal with officials of other governments and report to the department on developments that affect the United States. These reports give the President and the secretary of state much of the information on which U.S. foreign policy is based. Members of the Foreign Service also issue passports; grant visas to persons visiting or emigrating to the United States; protect U.S. citizens and their property in other countries; and help businessmen promote U.S. trade and investment.

The Department of State carries on educational and cultural exchanges with other countries. It arranges for students, teachers, and leaders to visit the United States, and for U.S. citizens to study and teach abroad. It promotes public understanding of United States foreign policy through information services and publications.

Four other government agencies responsible for foreign-affairs programs receive special guidance from the Department of State. One—the Agency for International Development (AID)—is part of the department and administers the United States foreign aid program. The other three—the United States Information Agency (USIA), the United States Arms Control and Disarmament Agency (ACDA), and ACTION—are independent agencies. USIA explains U.S. foreign policy and life in the United States to persons in other countries. ACDA formulates United States policy on the control of weapons and disarmament. ACTION administers a variety of federal volunteer programs, including the Peace Corps.

Secretary of State

Responsibilities. The secretary of state is appointed by the President with the approval of the Senate. He is the highest-ranking member of the Cabinet and comes after the Vice-President, the speaker of the House, and the president *pro tempore* of the Senate in order of succession to the presidency.

The secretary is the President's chief adviser on foreign affairs. He is responsible for operating the Department of State and carrying out foreign policy. He must identify the major international problems that the United States faces and develop the strategy to deal with them. The secretary serves on the National Security Council and the National Aeronautics and Space Council.

Relationship with the President and Congress. The role of the secretary depends on his relationship with the President. Some Presidents have had strong opinions concerning foreign policy and have formulated their own policy. Therefore, they have been, in effect, their own secretaries of state. Secretaries serving such Presidents have had less influence and prestige than those who have served Presidents who were primarily interested in domestic affairs.

The secretary's relationship to Congress is also vital because congressional actions often affect foreign affairs. For example, treaties negotiated by the secretary must be approved by the Senate. The Senate also passes on the appointment of ambassadors and other officials. The Congress controls the money that the secretary needs to carry out his policies. In fact, nearly every committee of Congress affects foreign policy. To gain congressional support, the secretary must present the administration's foreign policies effectively. His success with Congress depends mainly on the President's political strength in the country. But the secretary must try to keep partisan politics out of his dealings with Congress. Generally, Congress tries to take a *bipartisan* (nonpolitical) attitude in dealing with foreign affairs.

The type of man appointed secretary of state has changed over the years. In the late 1700's and early 1800's, the post often served as a stepping stone to the presidency. Thomas Jefferson, James Madison, James

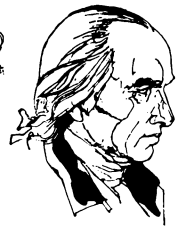
Department of State

The Department of State advises the President on United States foreign policy. The department's headquarters, above, are on C Street, Washington, D.C.

SECRETARIES OF STATE

The post of secretary of state was a stepping stone to the presidency during the early years of the United States. Six secretaries have become President. But none has become President since James Buchanan was elected in 1856.

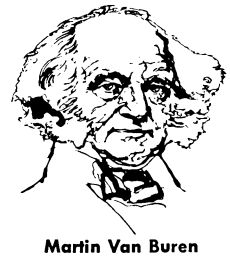
Thomas Jefferson



James Madison

James Monroe

John Quincy Adams



Martin Van Buren

James Buchanan

Name	Year Appointed	Under President
*Thomas Jefferson	1789	Washington
*Edmund Randolph	1794	Washington
*Timothy Pickering	1795	Washington, J. Adams
*John Marshall	1800	J. Adams
*James Madison	1801	Jefferson
Robert Smith	1809	Madison
*James Monroe	1811	Madison
*John Quincy Adams	1817	Monroe
*Henry Clay	1825	J. Q. Adams
*Martin Van Buren	1829	Jackson
Edward Livingston	1831	Jackson
Louis McLane	1833	Jackson
John Forsyth	1834	Jackson, Van Buren
*Daniel Webster	1841	W. H. Harrison, Tyler
Abel P. Upshur	1843	Tyler
*John C. Calhoun	1844	Tyler
*James Buchanan	1845	Polk
*John M. Clayton	1849	Taylor
*Daniel Webster	1850	Fillmore
*Edward Everett	1852	Fillmore
William L. Marcy	1853	Pierce
*Lewis Cass	1857	Buchanan
Jeremiah S. Black	1860	Buchanan
*William H. Seward	1861	Lincoln, A. Johnson
*Elihu B. Washburne	1869	Grant
*Hamilton Fish	1869	Grant
*William M. Evarts	1877	Hayes
*James G. Blaine	1881	Garfield, Arthur
F. T. Frelinghuysen	1881	Arthur
*Thomas F. Bayard	1885	Cleveland
*James G. Blaine	1889	B. Harrison
John W. Foster	1892	B. Harrison
Walter Q. Gresham	1893	Cleveland
*Richard Olney	1895	Cleveland
*John Sherman	1897	McKinley
William R. Day	1898	McKinley
*John M. Hay	1898	McKinley, T. Roosevelt
*Elihu Root	1905	T. Roosevelt
Robert Bacon	1909	T. Roosevelt
*Philander C. Knox	1909	Taft
*William J. Bryan	1913	Wilson
*Robert Lansing	1915	Wilson
Bainbridge Colby	1920	Wilson
*Charles E. Hughes	1921	Harding, Coolidge
*Frank B. Kellogg	1925	Coolidge
*Henry L. Stimson	1929	Hoover
*Cordell Hull	1933	F. D. Roosevelt
*Edward R. Stettinius, Jr.	1944	F. D. Roosevelt, Truman
*James F. Byrnes	1945	Truman
*George C. Marshall	1947	Truman
*Dean G. Acheson	1949	Truman
*John Foster Dulles	1953	Eisenhower
*Christian A. Herter	1959	Eisenhower
*Dean Rusk	1961	Kennedy, L. B. Johnson
*William P. Rogers	1969	Nixon
*Henry A. Kissinger	1973	Nixon, Ford

*Has a separate biography in WORLD BOOK.

Monroe, John Quincy Adams, Martin Van Buren, and James Buchanan all served in the office before being elected President. Other secretaries, such as Henry Clay, Daniel Webster, John C. Calhoun, and William H. Seward, were appointed secretary of state mainly because they were political leaders.

In the 1900's, secretaries have been selected mainly for their experience and ability in foreign affairs. John Hay was a career diplomat. Cordell Hull, who won the Nobel peace prize while secretary of state, had served in both the Senate and the House of Representatives. John Foster Dulles, who specialized in "personal diplomacy," had been a UN delegate and a senator. Both Christian Herter and Dean Rusk served in high State Department posts before becoming secretaries of state. Henry A. Kissinger was President Richard M. Nixon's top White House adviser on foreign policy before taking office as secretary of state.

Organization of the Department

The department's employees work both in the United States and in many countries overseas.

American Headquarters are in Washington, D.C. The department has about 6,500 employees in the United States, including those in Washington.

The secretary of state has six main assistants. The deputy secretary of state directs the department in the secretary's absence. The undersecretary for political affairs is the secretary's chief foreign policy adviser. The undersecretary for economic affairs is his chief adviser

STATE, DEPARTMENT OF

THE PRESIDENT

The Department of State acts as the President's chief adviser in forming and carrying out U.S. foreign policy. The departmental seal, *above*, is patterned after the Great Seal of the United States.

SECRETARY OF STATE

Arms Control and Disarmament Agency

Agency for International Development

DEPUTY SECRETARY OF STATE

Undersecretary for Political Affairs

Undersecretary for Security Assistance

Undersecretary for Economic Affairs

Counselor

Inspector General Foreign Service

Deputy Undersecretary for Management

Director General Foreign Service

Foreign Service Institute

Inspector General Foreign Assistance

Executive Secretariat

Press Relations

Planning and Coordination Staff

Protocol

Legal Adviser

Congressional Relations

Educational and Cultural Affairs

Economic and Business Affairs

Oceans and International Environmental and Scientific Affairs

Intelligence and Research

Politico-Military Affairs

Public Affairs

Security and Consular Affairs

Administration

African Affairs

European Affairs

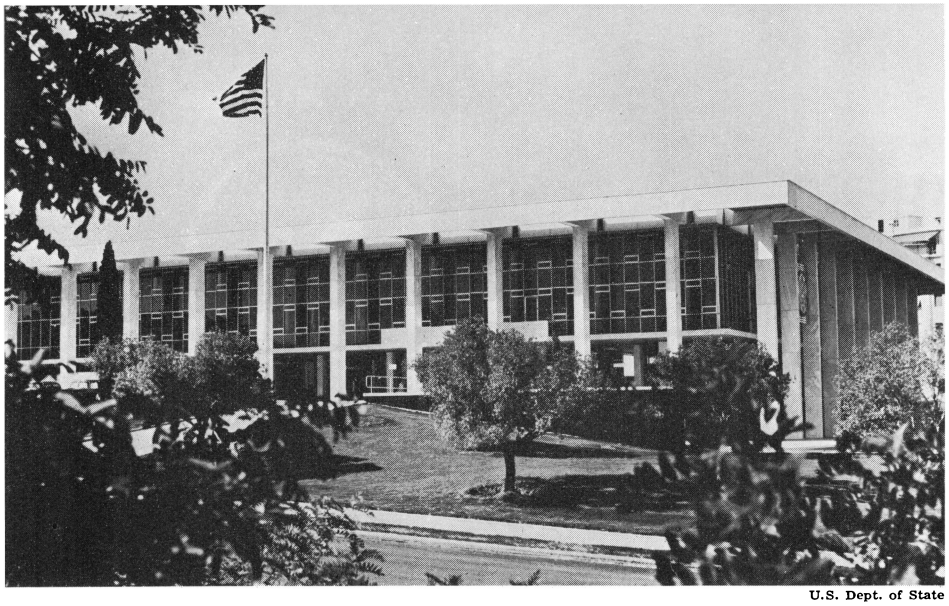
East Asian and Pacific Affairs

Inter-American Affairs

Near Eastern and South Asian Affairs

International Organization Affairs

Diplomatic Missions and Delegations to International Organizations



U.S. Dept. of State

United States Embassies serve as headquarters for American Foreign Service officials in most countries of the world. The United States embassy in Athens, *left*, houses the State Department delegation to Greece.

on foreign economic policy. The other senior advisers consist of the undersecretary for security assistance, the counselor, and the deputy undersecretary for management.

The *Planning and Coordination Staff* is made up of experts with no regular administrative duties. They devote themselves to planning and the coordination necessary to put foreign policy decisions into effect.

Specialized Bureaus, usually headed by assistant secretaries, do the day-to-day work of the department. Five bureaus, organized on a geographic basis, handle U.S. foreign relations. They are (1) European Affairs (which includes Russia), (2) Inter-American Affairs, (3) African Affairs, (4) Near Eastern and South Asian Affairs, and (5) East Asian and Pacific Affairs.

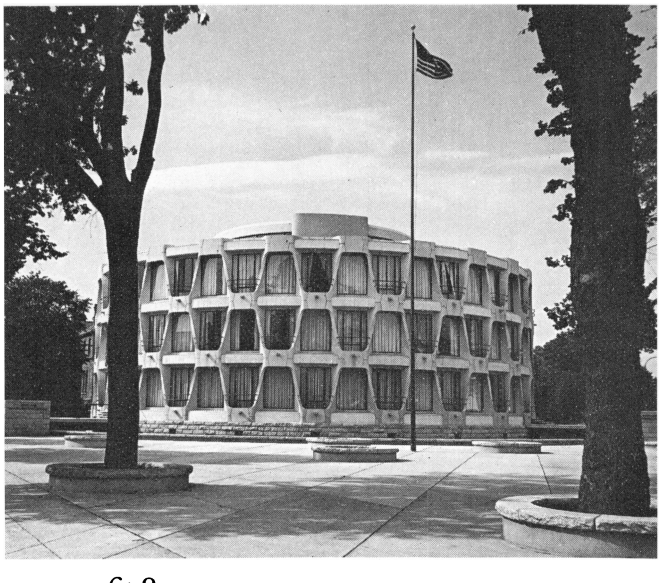
The Bureau of International Organization Affairs conducts U.S. relations with the United Nations and other international organizations. The Bureau of Economic and Business Affairs deals with international finance, trade, tariffs, shipping, aviation, and telecommunication matters. The Bureau of Intelligence and Research analyzes the information coming into the department and reports on international situations.

The Bureau of Educational and Cultural Affairs directs programs for student and cultural exchanges and for grants to educational institutions in other countries. The Bureau of Public Affairs informs the public on foreign affairs, distributes a wide variety of printed and audio-visual materials on current U.S. foreign policy, and keeps the official historical record of U.S. foreign relations. The Bureau of Security and Consular Affairs supervises such duties as issuing passports and visas and protecting U.S. citizens abroad. The deputy undersecretary for management administers the budget and personnel. The Bureau of Oceans and International Environmental and Scientific Affairs deals with such matters as conservation, oceans, and outer space.

The assistant secretary for congressional relations

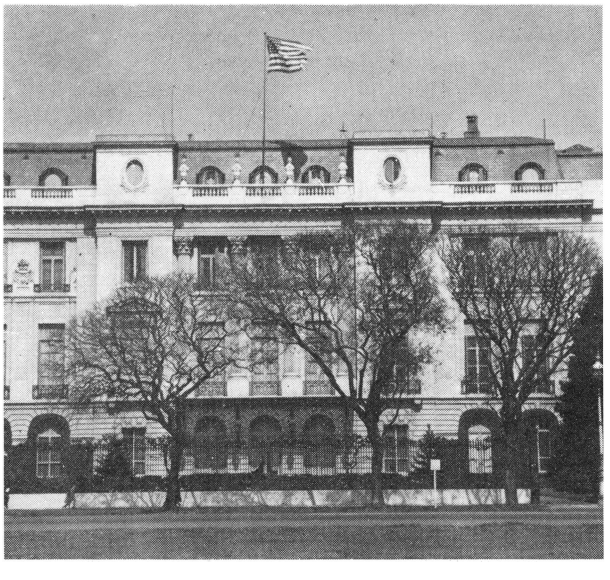
The American Embassy in Dublin houses the State Department delegation which represents the U.S. government in Ireland.

U.S. Dept. of State



The Embassy in Buenos Aires is the home of the American Ambassador to Argentina. American flags fly over U.S. embassies.

U.S. Dept. of State



handles affairs between the department and Congress. His office directs the presentation of the department's legislative programs to Congress.

The *Executive Secretariat* of the department coordinates recommendations for actions that come to the secretary and other senior department officials for decision. It directs the Operations Center, which maintains a round-the-clock watch on world affairs and keeps top department officials informed of world developments.

The *chief of protocol* advises the secretary in matters of national and international *protocol* (traditional courtesies shown to officials). For example, the chief of protocol handles the arrangements when the ruler of another country visits the President.

The *U.S. Mission to the United Nations*, in New York City, is part of the department's home organization. The *Mission of the U.S. Representative to the Council of the Organization of American States* (OAS), in Washington, D.C., is also under the department.

Overseas Missions. The department has about 260 Foreign Service posts in other countries. In the mid-1970's, about 5,600 employees of the American Foreign Service worked at overseas posts. The Foreign Service also employed about 10,500 citizens of other countries.

History of the Department

Establishment. The Department of State is the oldest executive department of the United States government. During the Revolutionary War, the Continental Congress dealt with other countries through its Committee on Secret Correspondence. This committee was established in 1775 with Benjamin Franklin as its first chairman. In 1777, the group was renamed the Committee for Foreign Affairs.

On Jan. 10, 1781, the Continental Congress created a Department of Foreign Affairs. Robert Livingston became the first secretary of foreign affairs, and John Jay succeeded him in 1784. After the adoption of the Constitution, Congress set up the Department of Foreign Affairs on July 27, 1789, as an executive agency under the President. Congress changed its name to the Department of State on Sept. 15, 1789. The department performed such domestic duties as operating the mint, issuing patents, and taking the census. Most domestic duties have since been transferred to other departments.

President George Washington appointed Thomas Jefferson as the first secretary of state in 1789. But Jay continued as temporary secretary until Jefferson assumed the office in 1790. Under Jefferson, the department had a staff of eight persons. The Foreign Service consisted of legations in London and Paris, an agency at The Hague, and 10 consular offices.

Growth. Before World War II, the department grew slowly. The interests of the United States then centered on domestic matters. Foreign affairs became important only during such crises as the Civil War and World War I. The U.S. shunned alliances with other countries, and the department received scant attention from the public and little support from Congress.

In 1833, separate bureaus were set up to supervise the work of U.S. diplomatic and consular representatives. In 1870, the department's work was spread among nine bureaus and two agencies. The Civil Service Act of 1883 and introduction of the merit system enabled the department to hire more highly qualified employees (see CIVIL SERVICE). In 1909 and 1910, the department added four geographic divisions to handle U.S. relations with the rest of the world.

The department's work increased greatly in World War I. Its Washington staff rose to more than 400 in 1918. After World War I, American foreign relations became more important and complex. Congress passed the Rogers Act in 1924 to strengthen the department's overseas organization. In 1939, the Foreign Service absorbed the separate overseas services of the Commerce and Agriculture departments.

World War II and the Cold War expanded department activities still more. The war showed that U.S. security depended on affairs in the rest of the world. Americans felt they must cooperate with other nations to maintain peace. The department took over various war agencies that had gathered information and dispensed aid abroad, and assumed new administrative duties in occupied Germany and Japan. It adopted new economic and military aid programs and set up security arrangements with over 40 nations. In 1946, the Foreign Service was reorganized. The Executive Secretariat was set up in 1947. In 1949 and 1950, the department adopted many of the Hoover Commission's recommendations (see HOOVER COMMISSION).

Between 1954 and 1957, the department integrated its home and foreign services. The office of the Inspector General, Foreign Assistance; the Peace Corps; and the Agency for International Development were established as agencies within the department in 1961. In 1971, the Peace Corps became part of ACTION. Also in 1971, the department started a modernization program to achieve its objectives more effectively.

Critically reviewed by the DEPARTMENT OF STATE

Related Articles in WORLD BOOK include:

Agency for International Development
Arms Control and Disarmament Agency, U.S.
Diplomacy
Diplomatic Corps
Flag (picture: Flags of the U.S. Government)
Foreign Aid
Foreign Policy
Foreign Service
International Relations
Peace Corps
Presidential Succession
United States Information Agency

STATE AND CHURCH. See CHURCH AND STATE.

STATE BANKS. See BANKS AND BANKING (Commercial Banks).

STATE BIRDS. See BIRD (table: State and Provincial Birds); UNITED STATES (table: Facts in Brief About the States); also color picture in each state article.

STATE CAPITALS. See UNITED STATES (table: Facts in Brief About the States).

STATE COLLEGES. See the Education section in each state article, such as ALABAMA (Education).

STATE FAIR. For the date and place of state fairs in the United States, see the Annual Events sections in the various state articles, such as ALABAMA (Annual Events).

STATE FARM. See EUROPE (Farm Organization).

STATE FLAGS. For a description and color picture of the flag of each state of the United States, see the color picture in each state article. For color pictures of all the state flags together, see the FLAG article.

STATE FLOWERS. See FLOWER (table: Flowers of the States); UNITED STATES (table: Facts in Brief About the States); also color picture in each state article.

STATE GOVERNMENT

STATE GOVERNMENT provides many services and regulates many activities for the people of a state. In the United States, a state government maintains law and order and enforces criminal law. It protects property rights and regulates business. It supervises public education, including schools and state universities. It operates public-welfare programs, builds and maintains most highways, operates state parks and forests, and regulates the use of state-owned land. It has direct authority over local governments—counties, cities, towns, townships, villages, and school districts.

The national government in some countries, such as Great Britain, operates under the *unitary system*. That is, it defines and establishes the powers of the local governments. But in the United States, a state government has independent powers of its own that are authorized by the Constitution. In such a *federal system*, the national government cannot change these powers formally without the agreement of the state government. The national government has its powers specified in the Constitution, and the state governments retain all the remaining powers, except where the Constitution restricts them. See STATES' RIGHTS.

The independent powers of state governments arose during the colonial period. After the Declaration of Independence in 1776, each former British colony quite properly called itself a *state* to indicate its sovereign position. The term generally means a group of persons who live in a definite territory, and who are organized under a sovereign government. Each state gave up some of its powers when the Constitution became the supreme law of the land in 1789. The state governments, like the federal government, have three main branches: (1) executive, (2) legislative, and (3) judicial.

Through the years, a strong tendency has developed toward enlarging the activities of the national government in the United States. Often a state must agree to accept some federal regulation in order to share in federal funds for particular purposes. An increasing centralization of functions within each state has also occurred. At the same time, cooperation among all levels of government—national, state, and local—has become an increasingly important development.

State Constitutions

Each state has a constitution that sets forth the principles and framework of its government. Every state constitution includes a bill of rights. Many have provisions on finance, public welfare, education, and the regulation of business.

The original 13 states had constitutions before the United States Constitution was adopted. Those of Massachusetts and New Hampshire are still in use, though they have been amended often. Constitutional conventions prepared most constitutions now in use.

A state constitution may be amended in several ways. The state legislature may submit a proposed amendment to the people for approval. The Delaware legislature may ratify such an amendment without a popular vote, but only by a two-thirds majority in each of two sessions. In 15 states, the people may suggest an amendment and vote on it in a state election. In some states, constitutional conventions may adopt amendments, subject to ratification by the people. In other states, a constitutional commission may propose an amendment, which must receive legislative approval before being submitted to the people.

Executive Branch

The Governor elected by the people heads the executive branch in each state. He has the power to appoint, direct, and remove from office a large number of state officials. The state constitution authorizes him to see that the laws are faithfully executed. The governor commands the state militia, grants pardons, and may call the state legislature into special session. He directs the preparation of the state budget. In almost all states, he may veto bills, and, in some states, may even veto parts of a bill. The governor is also the state leader of his political party.

Most state governors serve four-year terms. In four states, they hold office for two years. Eight state constitutions provide that the governor cannot serve two terms in succession. In 18 states, the governor cannot serve more than two terms in succession. In all states except Oregon, he may be removed from office by impeachment. In most states, a lieutenant governor succeeds him if he dies in office.

The powers of state governors in the United States have steadily increased. The first state governors had only limited authority because the people had learned to distrust the royal governors appointed by the kings of England. The office of governor has grown in stature since 1776. Some governors have more power than others. That is, they have more authority to appoint and control subordinate officials. See GOVERNOR.

Other Officers. In most states, the people elect several other executive officials. These officers usually include a lieutenant governor, secretary of state, treasurer, auditor, and attorney general. In some states, the governor or legislature appoints one or more of these officials. In over half the states, a state board of education or the governor appoints a superintendent of public instruction. In 19 states, the voters elect this official.

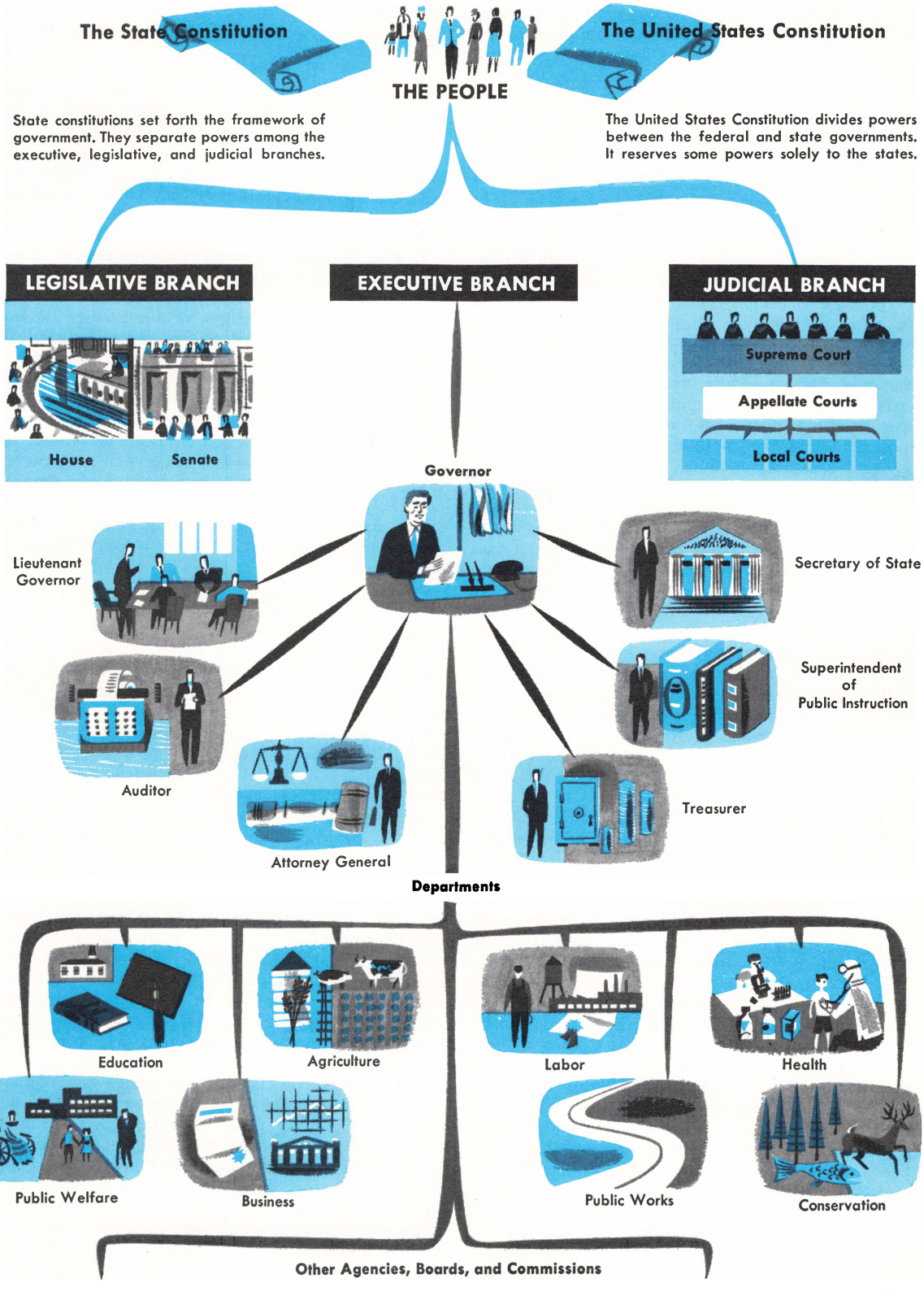
The secretary of state administers election laws, publishes legislative acts, and directs the state archives. The attorney general advises the governor and his staff on legal matters. He prosecutes or defends cases that involve the state. The superintendent of public instruction administers state schools. The treasurer collects and maintains state funds. The auditor receives claims against the state and decides which should be paid. He also examines the financial records of state agencies.

Legislative Branch

The legislature of a state passes laws, levies taxes, and appropriates money to be spent by the state government. It takes part in amending the state constitution and has the power to impeach officials.

Organization. Every state except Nebraska has a *bicameral* (two-house) legislature. Nebraska adopted a *unicameral* (one-house) legislature in 1934. Nineteen states call their legislature the *general assembly*, three call it the *legislative assembly*, and Massachusetts and New Hampshire call it the *general court*. Every upper house is known as the *senate*. Most states call the lower house the *house of representatives*. But four states use the term *assembly*, and three call it the *house of delegates*. A

ORGANIZATION OF A TYPICAL STATE GOVERNMENT



speaker presides over the lower house. The lieutenant governor presides over the senate in most states. In the others, the majority party selects a senate president.

Senators in most states serve four-year terms. They hold office for two years in the other states. In almost all states, members of the lower house serve two-year terms. In four states, they serve four-year terms.

State senates range in size from 20 members in Alaska and Nevada to 67 in Minnesota. The lower houses range from 40 members in Alaska and Nevada to 400 in New Hampshire.

Salaries of legislators vary from $100 a year in New Hampshire to $23,500 a year in New York. Legislators in some states receive daily payments while the legislature is in session, rather than yearly salaries. Payments vary from $5 a day in North Dakota and Rhode Island to $60 a day in Nevada. All states give legislators travel allowances, and many give other allowances.

The legislatures of over two-thirds of the states meet annually. The others meet in regular session *biennially* (every other year). Every legislature may be called into special session by the governor. The constitutions of most states limit the length of regular sessions.

The legislatures do much of their work through *standing*, or *permanent*, *committees*. The typical legislative chamber has about 18 such committees. Some states have joint committees, which include members from both houses. These committees report proposed bills to both houses. Many states set up *ad interim* (temporary) committees to study particular problems while the legislature is not in session. Almost all states also have legislative councils. These councils are permanent joint legislative committees that meet between sessions to study problems that may arise when the next legislative session opens. Council membership ranges from 5 in South Carolina to 253 in Pennsylvania. Legislative work has been speeded up greatly by such mechanical devices as electric roll-call machines. Many legislatures have legislative reference services to do research work and prepare reports. See LEGISLATURE.

Problems of Representation. In most states, the legislature handles the apportionment of representatives. For many years, most legislatures over-represented rural areas and under-represented the more heavily populated urban areas. Such unfair apportionment meant that urban voters could elect only about a fourth of the state legislators, though about two-thirds of all U.S. citizens lived in urban areas.

In 1962, in the case of *Baker v. Carr*, the Supreme Court of the United States ruled that individuals could bring questions of unfair districting before a federal court. In 1964, the court ruled that districts in both houses of a state legislature must be substantially equal in population. The court ruled in 1973 that states need not apply the principle of equal population so strictly to their legislative districts as to congressional districts. However, states had to attempt in good faith to make their legislative districts as nearly equal in population as possible. See APPORTIONMENT.

The people in 21 states share legislative power through the *initiative* and *referendum*. They may propose bills by petition and adopt them through referendum votes (see INITIATIVE AND REFERENDUM). Some persons believe that these procedures give the voters a check on their legislature, and increase public interest in government. Others maintain that they overburden the voters with decisions they cannot vote on intelligently, and that they tend to weaken the legislature's responsibility.

Judicial Branch

State courts settle disputes that come before them under various laws. They handle about nine-tenths of the criminal and civil cases in the United States.

A supreme court heads the judicial system of each state. In some states, the supreme court is called by another name, such as *court of appeals*. The memberships of state supreme courts range from three to nine judges. About half the states have seven-judge courts.

In more than half the states, the voters elect supreme court judges. In several states, the governor or legislature appoints them. In others, such as California, the governor appoints the judges, who must then be approved by the voters. Judges hold office for specified terms. These terms range from 2 years in Vermont to 15 in Maryland. Judges serve 6-, 8-, or 10-year terms in many states, and life terms in a few states.

Some states have intermediate appellate courts to handle some cases that would otherwise go directly to the supreme court. Each state has general trial courts. Local and special courts include county, municipal, probate, juvenile, domestic relations, and small-claims courts, and the courts of justices of the peace and police magistrates. Most judges in these courts serve four-year terms. See COURT.

State Services

Education. The states, rather than the federal government, have had the main responsibility for public education. State governments support public schools through taxes, and administer them through local school districts. Most districts supervise their public elementary and secondary schools under a school board elected by the people or appointed by the mayor. State governments set up general standards for schools and their courses of study. The state funds supplement local property taxes that help pay for education. Every state has at least one state university. It also maintains such institutions as agricultural colleges, teacher-training schools, junior colleges, and vocational schools.

Public Safety. The state legislatures enact most criminal laws that protect persons and property. State police promote highway safety, preserve the peace, and enforce criminal laws. Each state maintains prisons, reformatories, or prison camps. Some states have departments to promote mine safety, pollution control, and sanitation. Each state has a civil-defense organization to cooperate with the federal government. The governor commands the state militia, or national guard.

Public Works. Each state has a highway, public-works, or transportation department that builds and maintains highways. This department may also supervise the construction of bridges, grade separations, canals, and waterways, and take care of beach protection, flood control, and buildings and grounds. Many toll roads are built and operated by special state turnpike authorities appointed by the governor. All states erect and maintain large numbers of public buildings. Since 1931, the states have built many public works

with the aid of subsidies from the federal government.

Recreation. Departments or agencies in the various states manage more than 3,300 state parks and recreation areas. Many parks and recreation areas have been established in state-owned forests. Other areas have been set up as historical monuments. State highway departments may operate roadside parks for motorists.

Health. State departments of health, or boards of health, were first set up in the late 1800's. They supervise and assist local public-health agencies. These agencies are responsible for such activities as keeping vital statistics, controlling communicable diseases, and promoting health education, maternal and infant care, sanitation, and hygiene. They have general control over hospitals, nursing, research, and laboratory facilities. State public-health work may also include improvement of substandard housing and slum clearance.

Welfare. Aid from the federal government has stimulated state government activities in welfare programs. Each state operates programs that help the poor, aged, delinquent, and unemployed, and the mentally and physically handicapped. States also provide institutional care in hospitals, asylums, reformatories, and various types of homes. Welfare agencies administer the welfare programs in most states.

Conservation activities include protection of water resources through special drainage, irrigation, water-supply, and sanitation districts, and soil and forest conservation. State governments carry out their responsibilities through education; extension services; and research on water resources, fish and wildlife, forests, soils, and mineral resources. A director or board heads most conservation departments. Some states have fish and game commissions and forest services.

Agriculture. The states aid agriculture through county agents, soil-conservation districts, agriculture-extension services, and agricultural colleges. Most states have a department or board of agriculture. In most of these states, the governor appoints the director or board members. In others, the voters elect them. Annual state fairs are held in many states.

Business and Labor. Each state government grants corporations the charters that allow them to do business. It regulates banks, insurance companies, and savings and loan associations. It supervises public-utility companies that provide public power, communications, and transportation. All states have workers' compensation laws that provide payments to workers who are injured on the job.

State Finances

State governments must have money to pay for the services they provide. Most of a state's budget goes into payments for education, financial administration, highways, public welfare, health and hospitals, insurance trusts for retirement of employees and for unemployment compensation, prisons, public safety, natural resources, and interest on debt.

In most of the states, the governor receives the financial requests of the state agencies, and submits a total budget to the legislature. The legislature must approve all appropriations. Almost all state constitutions impose debt limitations upon the states.

Grants-in-aid from the federal government rank as the largest single source of state income. In 1971, such grants totaled more than $31 billion. Other major sources of income include taxes on property, general sales, motor fuel, alcoholic beverages, tobacco, motor-vehicles, individual and corporate incomes, inheritance and gifts, and the use of natural resources.

Local authorities usually collect property taxes, and turn over a share to the state government. Central state agencies collect such state levies as income, motor-vehicle, and business taxes. Most states have a tax commission that supervises tax administration.

Local governments rely heavily upon grants-in-aid from the states. They receive these grants upon agreeing to certain conditions, such as meeting standards imposed by the state. State governments also place debt limits upon local governments. See TAXATION.

In 1972, Congress passed the State and Local Fiscal Assistance Act. This revenue-sharing bill authorized the federal government to allocate about $30 billion to states and local communities for the next five years. A third of each state's share goes to the state government, and two-thirds goes to local governments within the state. See REVENUE SHARING.

Relations with Other Governments

The federal government has certain constitutional obligations toward the states. It must respect their territorial unity, and cannot divide or break up a state without its consent. It must protect the states against invasion and domestic violence. It must guarantee each state a republican form of government.

The United States Constitution also places certain limitations on the states. They may not interfere in foreign relations, or make compacts among themselves without the consent of Congress. They may not directly burden or discriminate against interstate commerce. They may not levy import or export taxes. They may not issue paper money or pass laws impairing the obligation of contracts.

The Constitution also places certain obligations on the states in their relations with each other. Each state must give "full faith and credit" to the legal processes and acts of every other state. No state may discriminate in favor of its own citizens against persons coming from other states. The Supreme Court of the United States can ultimately decide disputes between states that cannot be settled by negotiation and agreement. For a more complete description of the provisions, meaning, and interpretation of the Constitution, see CONSTITUTION OF THE UNITED STATES. DAVID FELLMAN

Related Articles. See the Government and History sections of each state article, such as ALABAMA (Government; History). See also the following articles:

Apportionment
Canada, Government of
Charter
City Government
Conservation
Corporation
County
Court
District Attorney
Education
Franchise
Government
Governor
Health, Board of
Initiative and Referendum
Legislature
Lieutenant Governor
Local Government
Metropolitan Area
National Guard
Police
Prison
Public Utility
Recreation
Roads and Highways
School
Social Work
States' Rights
Taxation
Transportation
United States, Government of the
Workers' Compensation

STATE MOTTOES. See the Facts in Brief table in each state article, such as ALABAMA (Facts in Brief).

STATE PARKS. See the Places to Visit section of each state article.

STATE POLICE. See POLICE (State Police).

STATE POPULAR NAMES. See UNITED STATES (table: Facts in Brief About the States of the Union).

STATE PRESS is a system of publishing operated by a government or a government-controlled political party. It is the opposite of a *free press*, where individuals publish newspapers and magazines. Freedom of the press is an important element in political freedom. Dictatorships rely on state presses to control public opinion.

See also FREEDOM OF THE PRESS.

STATE SEALS. See the picture in each state article.

STATE SONGS. See the Facts in Brief table in each state article, such as ALABAMA (Facts in Brief). See also UNITED STATES (table: Facts in Brief About the States).

STATE TREES. See the color picture in each state article; also UNITED STATES (table: Facts in Brief About the States of the Union).

STATEMENT. See BILL; CHECK.

STATEN ISLAND forms a borough of New York City. The island lies in New York Bay, about 5 miles (8 kilometers) southwest of Manhattan Island (see NEW YORK [political map]). Staten Island has a population of 295,443.

Ferries link Staten Island with Manhattan. The Verrazano-Narrows Bridge connects Fort Wadsworth on Staten Island with Fort Hamilton in Brooklyn. Three other bridges connect the island with New Jersey. Staten Island covers 64 square miles (166 square kilometers). It is about 14 miles (23 kilometers) long and $7\frac{1}{2}$ miles (12 kilometers) across at its widest point.

Like Manhattan Island, Staten Island was purchased by the Dutch from the Indians in the 1600's. The borough was known as Richmond until 1975, when it was renamed Staten Island. WILLIAM E. YOUNG

See also NEW YORK CITY (Staten Island); RICHMONDTOWN.

Staten Island, *foreground,* **and Brooklyn are connected by the Verrazano-Narrows Bridge. The bridge was completed in 1964.**
Triborough Bridge and Tunnel Authority

STATER. See MONEY (The First Coins).

STATES-GENERAL, often called ESTATES-GENERAL, was the French representative assembly from 1302 to 1789. It was divided into three *estates* (classes). The first estate represented the clergy, the second the noblemen, and the third the commoners. In the later Middle Ages, the kings began to invite leaders from each of the three estates to meet and discuss legislative or financial matters. These assemblies did not win the power to make laws for many years.

France's states-general never gained the power that England's parliament held. Its influence was limited because each estate met separately and voted as a unit. By the time of Louis XI, in the late 1400's, the states-general asked the king to govern without it. It never even met during the reign of Henry IV, from 1589 to 1610, and only for a short time under his son, Louis XIII. When he dismissed the states-general, it was not called again until the eve of the French Revolution in 1789, 175 years later.

When the states-general met in 1789, members of the third estate insisted on voting individually, instead of allowing each house to cast one vote. The first and second estates resisted this demand. On June 17, 1789, the third estate declared itself to be the national assembly of France. Three days later, its members swore in the Tennis Court Oath that they would not disband until they had written a constitution. Under threats of violence, Louis XVI recognized the national assembly as France's representative government.

The name *states-general* was also used in The Netherlands from 1593 to 1796 for an assembly where each province had one representative and one vote. It became the National Assembly in 1796. The Dutch parliament is now called States-General. EDWIN J. WESTERMANN

See also FRENCH REVOLUTION.

STATES OF THE CHURCH. See PAPAL STATES.

STATES' RIGHTS is a doctrine aimed at protecting the rights and powers of the states against those of the federal government. The 13 American states gave up many powers to the federal government when they ratified the United States Constitution. Only those powers that the Constitution did not grant to the national government were left to the states.

Everyone agrees that the states have rights that the federal government cannot lawfully touch. But the Constitution says that the federal government can make any laws that are "necessary and proper" for carrying its specific powers into effect. This provision makes it difficult to determine exactly what rights the states possess. Therefore, the major issue is not whether the states have rights, but rather who is to decide when these rights are abused.

Early History. Today, most people connect the support of states' rights with the South's position on racial segregation. But historically, the doctrine has been invoked by states in every section of the country whenever they have felt their jurisdiction threatened. One of the earliest instances was the Kentucky and Virginia Resolutions, which made a strong claim for the right of each state to decide this issue for itself. This idea gave rise to the doctrine of *nullification*, which asserts that within its own borders, a state can *nullify* (declare illegal) those acts of the federal government which it considers an invasion

of its own rights. The doctrine of nullification was developed by John Calhoun and officially adopted by South Carolina in 1832. See NULLIFICATION.

In 1860 and 1861, 11 Southern states carried the states' rights idea to its most extreme point by seceding from the Union. Their defeat in the Civil War put an end to this particular interpretation of states' rights. But it is still generally agreed that the states have a jurisdiction which the federal government has no right to invade. The task of drawing the exact line of state jurisdiction and deciding whether the federal government has overstepped it is now left to the federal courts. The decisions of the courts can be changed only by the courts themselves, or by an amendment to the United States Constitution.

Later Developments. In the 1950's, supporters of states' rights claimed that decisions of the federal courts weakened the powers of the states. The Supreme Court of the United States declared that state laws ordering segregation in public schools, in public parks, and on public transportation systems violated provisions of the Constitution. It also set aside state antisedition laws and "right to work" legislation. But states' rights supporters claimed that these decisions violated the police powers of the state.

In the controversy over segregation, advocates of states' rights insisted that each state has the right of *interposition*. This doctrine resembles nullification. It asserts that a state has the right to "interpose the sovereignty of a state against the encroachment upon the reserved power of the state." Under this doctrine, a state has the power to overrule a decision of a federal agency if it conflicts with a state law, and all persons in the state must obey the state, not the federal, law.

Congress set up a Commission on Intergovernmental Relations in 1953 to study the extent of federal aid to the states, and the constitutional limits of federal and state powers. In 1955, the commission made its recommendations to the President and Congress. The recommendations covered such fields as agriculture, education, and housing. The commission noted that the Constitution forbids the states to legislate in such fields as interstate commerce, admiralty laws, and currency. It pointed out that the problem of maintaining a federal system arises where both the federal and state governments have a choice of how to act.

States' rights parties have run candidates in most presidential elections since 1948. The core of these parties came from conservative Democrats and Republicans who opposed the civil-rights policies of their own parties. One of these groups, the States' Rights Democratic Party (nicknamed the Dixiecrat Party), carried four Southern states in 1948. In 1968, George C. Wallace, the American Independent Party's presidential candidate, also stressed states' rights and carried five Southern states. DAVID HERBERT DONALD

See also ALABAMA (Early Statehood); CALHOUN, JOHN CALDWELL; DIXIECRAT PARTY; KENTUCKY AND VIRGINIA RESOLUTIONS; WALLACE, GEORGE C.

STATES' RIGHTS DEMOCRATIC PARTY. See DIXIECRAT PARTY.

STATESMAN is a person with a broad general knowledge of government and politics, who takes a leading part in public affairs. Most persons think of statesmen as being concerned with the needs and interests of their country as a whole. In contrast, they think of *politicians* as having only party or political aims. *Elder statesmen*, usually retired from active government, continue to give advice on important issues. Japan developed this system in the *genro*, a council of former government leaders who advise the current government. See also the list of biographies of statesmen at the end of most country articles.

STATIC, *STAT ik*, is a broad term covering any electrical atmospheric disturbance. People hear it as a crashing or grating noise over the radio. Usually lightning or some other electrical disturbance in the air causes it. Motors or other electrical devices, especially those devices with a rotating or vibrating contact, also may cause static.

Every water droplet in a cloud carries a tiny charge of electricity. As droplets combine to make bigger drops, and finally to make rain, the electricity on the drops collects. Then the voltage rises so high that a spark jumps, either to another cloud or to the ground.

There are two sorts of static sounds. Small clouds or isolated water drops give a hissing noise like escaping steam, but large electric sparks give a loud snap or crash. Weather observers, using a kind of radio compass called a radio storm detector, can tell the direction and intensity of a storm by listening to the sound of its static, even when the storm is far away.

Static eliminators have been tried in radio sets, but without much success. One of the great advantages of frequency modulation (FM) radio is that it does not have static. PALMER H. CRAIG

See also FREQUENCY MODULATION.

STATIC ELECTRICITY. See ELECTRICITY (Static).

STATICE, *STAT ih see*, is a group of colorful plants used in rock gardens and flower-bed borders. It includes the *thrift* (or *sea pink*) and the *sea lavender*. The thrift has narrow, evergreen leaves that grow in large bunches. Its small pink or white flowers grow in dense, globe-shaped clusters. The sea lavender has wider leaves and purple, rose, white, or yellow flowers. These flowers are often dried and made into bouquets for winter use. Statices are hardy and grow well in most garden soils. They usually reproduce by seed. Started in a greenhouse in early spring and then planted outside, they have flowers all summer.

Scientific Classification. The statice belongs to the leadwort family, *Plumbaginaceae*. Two common thrifts are classified as genus *Armeria*, species *A. maritima* and *A. pseud-armeria*. Other common statices include *Limonium sinuatum* and *L. latifolium*. ROBERT W. SCHERY

STATICS is a branch of the science of dynamics. Dynamics deals with the properties of matter and forces. It is divided into two branches—*statics* and *kinetics*. Statics deals with conditions under which material bodies do not change motion when acted upon by various forces. That is, a body at rest will remain at rest, and a body in motion will not change direction or speed of motion. When two or more forces act upon a body so as to produce no change of motion, the forces are said to be in *equilibrium*. Kinetics deals with the changes of motion. See also DYNAMICS. ROBERT F. PATON

STATION, RAILWAY. See RAILROAD (picture: During World War II).

STATISTICS

STATISTICS, *stuh TISS ticks.* Suppose someone handed you records containing the weights of 13,000 newborn babies. Then he asked you to make some conclusions about the weights. Many persons could be puzzled by page after page of nothing but numbers. Great masses of *data* (facts) usually tend to be confusing. But statistics, a branch of mathematics, has ways of simplifying masses of numbers and facts and of presenting them in an understandable form. For example, a statistician could find that the average weight of the newborn boys is 7.35 pounds and that of the girls is 7.13 pounds. Now you have some easily understood conclusions about the weights. In ways such as this, statistics can help you solve many problems.

The word *statistics* appears sometimes as a singular and sometimes as a plural noun. As a plural noun, *statistics* refers to numbers or numerical facts. For example, you can say that "there *are* many statistics in THE WORLD BOOK." As a singular noun, *statistics* refers to the methods used to analyze numerical data, and to draw conclusions from them. You can say that "statistics *is* the art and science of analyzing numerical data."

Uses of Statistics

As a science, statistics began in Germany in the 1700's and 1800's. Governments used statistics to count their citizens and to collect taxes. Governments still use statistics for these and many other purposes, such as planning farm production.

Scientists know that it is unsafe to draw conclusions from small numbers of observations. So they find it necessary to study thousands and even millions of cases. Statistics helps all the sciences—physical, biological, and social—to deal with masses of facts.

Statistics makes vital contributions to business and industry. Statistical methods help to organize business and industrial facts, and uncover the principles and trends at work behind the facts. Advertising, finance, insurance, manufacturing, retailing, and many other fields depend on statistics. Statistics helps politicians plan their campaigns, and the use of statistics forms the basis of public-opinion polls.

How Statistics Works

Solving any problem in statistics involves three steps: (1) definition of the problem, (2) collection of data, and (3) analysis of data.

Definition of the Problem. Beginners in statistics usually learn with surprise that even the simplest problem requires careful definition. Suppose someone asks you to count the words on a printed page. You will discover immediately that you must answer questions about this simple problem. For example, how many words are there in the sentence, "The Civil War (1861-1865) created a new public-school shortage in the U.S."? Do you count abbreviated words? How about hyphenated words and numbers? You must define what you mean by *words* before you begin. Similar questions appear in statistics. Suppose you want to count the population of the United States on Apr. 15, 1960. Whom do you count? Do you include a baby born late that afternoon? A man who died early that morning? A person from another country visiting the United States? A United States citizen visiting another country? You must define your terms with great care.

Collection of Data. After defining his terms, a statistician proceeds to collect his data. Sometimes he can use data collected by others, such as census figures or school records. This kind of data is called *derived data.* Sometimes a statistician has to obtain his own data. His own data might consist of such things as laboratory experiments, questionnaires sent to housewives, or personal interviews. This kind of data is called *original data.*

Analysis of Data. Defining the problem and collecting data have fundamental importance. But a statistician spends most of his time analyzing the data. That is, he tries to find out what the data mean and how they may be interpreted. In some cases, this involves nothing more complicated than computing an average or finding a percentage. In other cases, analyzing the data may require months of labor and the use of giant electronic computers.

Averages

Suppose a statistician received the records of the number of eggs laid in one year by each of 3,131 White Leghorn hens. He usually arranges values such as these in a *table:*

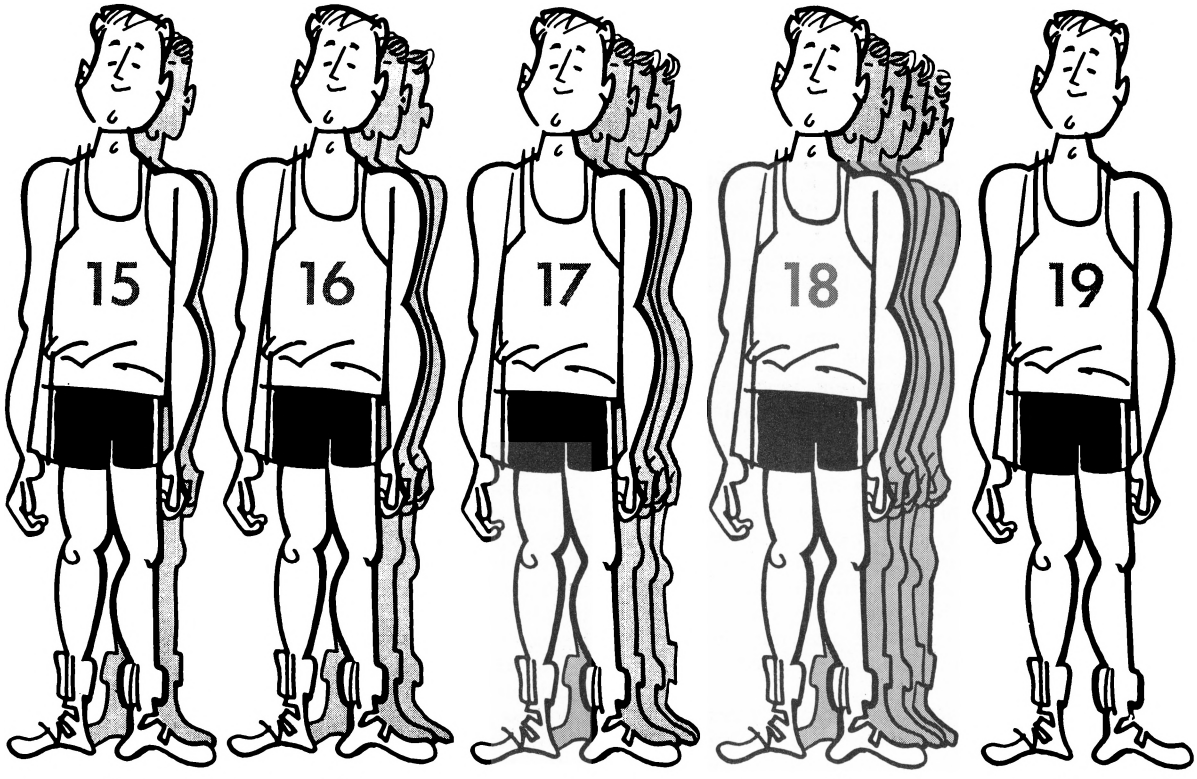
NUMBER OF EGGS	NUMBER OF HENS
0- 29	30
30- 59	36
60- 89	125
90-119	327
120-149	686
150-179	925
180-209	697
210-239	271
240-269	32
270-299	2
	TOTAL 3,131

Just a glance at the table makes the pattern clear. You can see that there is a bunching near the middle of the table. The most common egg production lies somewhere between 150 and 179 eggs. It looks as if the most common or most "popular" production is about 165 eggs, or halfway between 150 and 179. Statisticians call this kind of average the *mode.* A study of the actual data from which the table was prepared shows that as many hens laid more than 162 eggs as laid fewer than 162 eggs. This kind of average is the *median.* The median in the table is 162 eggs. If you add together the numbers of all the eggs and divide by 3,131, the number of hens, you will find the *arithmetic average* or *arithmetic mean.* The mean number of eggs is 157. See AVERAGE; MEAN; MEDIAN; MODE.

Frequency Distributions

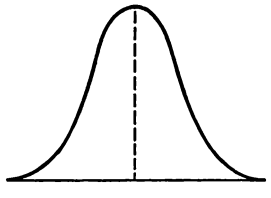
The egg-production table is called a *frequency table,* because it shows the frequency with which various values occur. A frequency table makes it possible for statisticians to gather thousands of cases into a small space. It also shows immediately the general characteristics of the data. Methods exist for the rapid computation of the mean, median, mode, and other useful numbers from frequency tables.

The values themselves, arranged in a table, form a *frequency distribution.* Many, although by no means all, frequency distributions show the same basic pattern



Statistics Can Tell a Great Deal about the ages of the members of this basketball squad. First, you can find the squad's *mean*, or average, age by adding together all the members' ages and dividing by the number of players on the squad. The mean age for the squad is 17 years. Second, you can find the *median* age by listing the ages of all the players from youngest to oldest and finding the age in the middle. The median age for the squad is 17. You can also use statistics to find the *mode* or the age that occurs the most number of times. The mode for the squad is 18, because there are more 18-year-olds than members of any other age.

that appears in the egg-production table. This distribution consists of small frequencies at both ends of the table and large frequencies in the middle. The distribution can be charted, by showing the numbers of cases vertically and the sizes of values horizontally. Here is the chart:



This bell-shaped distribution is called a *normal distribution* or *normal curve*.

Probability

With certain kinds of data, a statistician can tell in advance what values will occur, and how frequently. Suppose you toss a penny over and over again. You expect it to show "heads" half the time and "tails" half the time. If you toss it only three or four times, this may not happen. But as you increase the number of throws, the proportion of "heads" tends to draw more and more closely to the expected value of one half. Suppose you toss four pennies over and over again. Suppose you toss a very large number of pennies a great number of times. You may be surprised to find that the distribution of "heads" and "tails" draws closer and closer to the bell-shaped normal distribution. *Probability*, in statistics, is the measurement of the likelihood of events in numerical terms. The normal distribution, based on pure chance, helps statisticians to make these measurements.

Sometimes a statistician can reason out in advance the relative frequency with which events will occur, such as tossing coins or throwing dice. This is called *a priori probability* (probability *from the first*). But, in many cases, a statistician cannot reason out probability in advance; for example, whether or not a certain patient will recover from diphtheria. But he can reach fairly reliable conclusions as to these probabilities from a study of actual cases. For example, he might find

that the probability of recovering in diphtheria cases is 78 out of 100. This is called *statistical probability.*

In a normal distribution, the distance you must go above and below the arithmetic mean to include half of the cases is called the *probable error* of the distribution. In any normal distribution, 50 per cent of the cases lie within one probable error of the mean, 82 per cent lie within two probable errors, 96 per cent within three probable errors, 99.3 per cent within four probable errors, and 99.92 per cent within five probable errors.

Statisticians now use a similar measure called the *standard error* more than the probable error. The standard error has certain mathematical advantages. In a normal distribution, 68.27 per cent of the cases lie within one standard error of the mean, 95.5 per cent lie within two standard errors, and practically all the cases (99.7 per cent) lie within three standard errors.

Sampling

Statisticians know that it is risky to draw conclusions from small numbers of observations. Yet usually it is impossible to study all the cases. A statistician must study a group of a hundred, a thousand, or some other limited number of cases. Statisticians call the group they actually study the *sample.* They draw their conclusions from this group. The total number of cases from which they select the sample is called the *universe* or the *population.*

A statistician can never be completely certain that his sample accurately reflects the total number of cases. But, in general, the larger the sample, the more reliable it is in reflecting the total number of cases. The reliability of the sample increases, not in proportion to the number of cases, but in proportion to the square root of the number of cases. To double the reliability, a statistician studies four times as many cases. To treble the reliability, he studies nine times as many cases.

A statistician must decide how many cases to study, and which individual cases. He tries to select the individual cases carefully. Often he uses a *random sample.* A random sample consists of cases selected so that each case in the total number has an equal chance of being included.

ALBERT E. WAUGH

Related Articles in WORLD BOOK include:

Average	Graph	Median
Econometrics	Mean	Mode
Pearson, Karl	Probability	Skew Line
Permutations and Combinations	Public Opinion Poll	Vital Statistics

STATISTICS, VITAL. See VITAL STATISTICS.

STATLER, ELLSWORTH MILTON (1863-1928), was an American hotel owner and operator. He built a hotel for the Buffalo Exposition in 1901, and operated one at the St. Louis Exposition in 1904. He opened a permanent hotel in Buffalo in 1908, advertising it as the first in the country to have a bath with every room. He later owned hotels in Cleveland, Detroit, and St. Louis, and operated the Pennsylvania in New York City. He was born on Oct. 26, 1863, in Somerset County, Pennsylvania.

DONALD L. KEMMERER

STATOR. See ELECTRIC GENERATOR (Parts).

STATUARY HALL is one of the large rooms in the United States Capitol in Washington, D.C. It is set aside to house the statues of outstanding citizens of each state. The hall itself is in the form of a half circle under a half dome. It lies near the rotunda, on the side of the Capitol leading to the chamber of the House of Representatives.

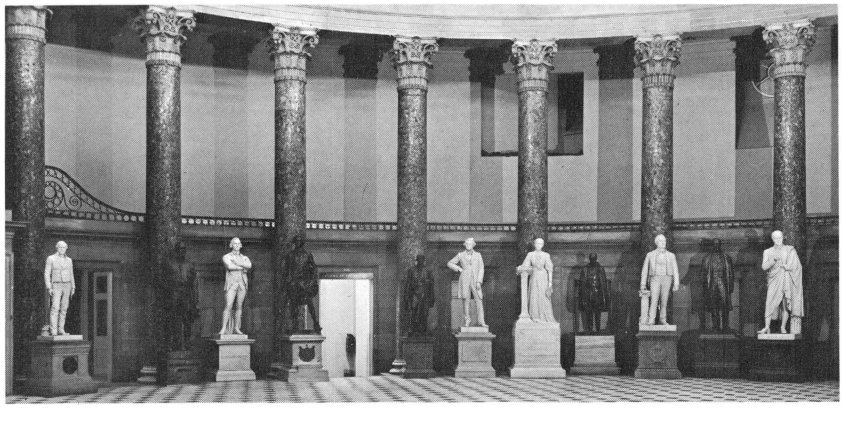
Purpose. In 1864, Congress authorized the President to invite each state to send two marble or bronze statues to be displayed in the Capitol. The states were asked to choose citizens who had performed distinguished civic or military services and who were "worthy of this national commemoration." Congress set aside the old House of Representatives chamber to hold the statues.

The collection of statues grew over the years. In 1933, architects discovered that the hall was overloaded. Congress passed a law in 1933 authorizing the relocation of any of the statues elsewhere in the Capitol.

The Statues. By 1971, all 50 states had sent at least one statue to stand in Statuary Hall or elsewhere in the Capitol. Many of the leaders honored were statesmen, governors, members of Congress, or senators. Several pioneers, religious leaders, reformers, educators, and physicians have also been honored. Four women are represented among the statues in Statuary Hall.

The Hall that now stands as a memorial was the scene of many exciting events in the history of the United States. The House of Representatives met in the chamber for 50 years, from 1807 to 1857, with the exception of the period from 1814 to 1819. The Capitol was then being repaired after British soldiers burned it during the War of 1812. Many famous Americans, including John C. Calhoun, Stephen A. Douglas, Abraham Lincoln, and Daniel Webster, won their first

Architect of the Capitol



Statuary Hall in the U.S. Capitol in Washington, D.C., contains statues of distinguished citizens of the United States. Each state may place one marble or bronze statue in the hall. The first statue honored Nathanael Greene of Rhode Island in 1870.

national prominence in the House chamber. Henry Clay presided over many bitter debates. The House of Representatives met there in 1825 to choose the President in the contested election of 1824, and elected John Quincy Adams. In 1848, while serving as a representative, Adams suffered a stroke in the chamber, and died soon afterward. Millard Fillmore took the oath as President in the chamber in 1850.

Critically reviewed by the UNITED STATES CAPITOL HISTORICAL SOCIETY

STATUE. See SCULPTURE.

STATUE OF LIBERTY. See LIBERTY, STATUE OF.

STATUE OF LIBERTY NATIONAL MONUMENT is on Ellis and Liberty islands in New York harbor. The colossal statue by Frédéric Bartholdi stands on Liberty Island. The people of France presented it to the United States on July 4, 1884. Ellis Island was an immigration station until 1954. It became part of the monument in 1965. See also ELLIS ISLAND; LIBERTY, STATUE OF.

STATUTE OF LIMITATIONS

STATUTE, *STAT yoot,* is a rule of law passed by a law-making body such as the Congress of the United States. *Statute law* is another term for *written law.* The term distinguishes written law from *unwritten* or *common law,* which is based upon custom and upon previous court decisions. See also COMMON LAW.

STATUTE MILE. See MILE.

STATUTE OF FRAUDS. See FRAUD.

STATUTE OF LIMITATIONS is a law that sets a time limit for the filing of lawsuits. Suits filed after the statute of limitations has passed are barred, no matter how just they may be. Statutes of limitations prevent lawsuits in which the true situation is clouded because of a long lapse of time.

Each state as well as the federal government has its own statute of limitations for different kinds of claims.

STATUES IN THE CAPITOL

State	In Statuary Hall	Date Presented	Elsewhere In the Capitol	Date Presented
Alabama	Joseph Wheeler	1925	J. L. M. Curry	1908
Alaska			Edward Lewis (Bob) Bartlett	1971
Arizona	John C. Greenway	1930	Eusebio Francisco Kino	1965
Arkansas	Uriah M. Rose	1917	James P. Clarke	1921
California	Junípero Serra	1931	Thomas S. King	1931
Colorado	Florence Rena Sabin	1959		
Connecticut	Roger Sherman	1872	Jonathan Trumbull	1872
Delaware	Caesar Rodney	1934	John M. Clayton	1934
Florida	John Gorrie	1914	Edmund Kirby Smith	1922
Georgia	Alexander H. Stephens	1927	Crawford W. Long	1926
Hawaii	Kamehameha I	1969	Joseph Damien de Veuster	1969
Idaho	George L. Shoup	1910	William E. Borah	1947
Illinois	Frances E. Willard	1905	James Shields	1893
Indiana	Lew Wallace	1910	Oliver P. Morton	1900
Iowa	Samuel J. Kirkwood	1913	James Harlan	1910
Kansas	John J. Ingalls	1905	George W. Glick	1914
Kentucky	Henry Clay	1929	Ephraim McDowell	1929
Louisiana	Huey P. Long	1941	Edward Douglass White	1955
Maine	Hannibal Hamlin	1935	William King	1878
Maryland	Charles Carroll of Carrollton	1903	John Hanson	1903
Massachusetts	Samuel Adams	1876	John Winthrop	1876
Michigan	Lewis Cass	1889	Zachariah Chandler	1913
Minnesota	Henry Mower Rice	1916	Maria L. Sanford	1958
Mississippi	Jefferson Davis	1931	James Z. George	1931
Missouri	Thomas H. Benton	1899	Francis P. Blair, Jr.	1899
Montana	Charles M. Russell	1959		
Nebraska	William Jennings Bryan	1937	J. Sterling Morton	1937
Nevada	Patrick A. McCarran	1960		
New Hampshire	Daniel Webster	1894	John Stark	1894
New Jersey	Richard Stockton	1888	Philip Kearny	1888
New Mexico			Dennis Chavez	1966
New York	Robert R. Livingston	1875	George Clinton	1873
North Carolina	Zebulon Baird Vance	1916	Charles B. Aycock	1932
North Dakota	John Burke	1963		
Ohio	William Allen	1887	James A. Garfield	1886
Oklahoma	Sequoya	1917	Will Rogers	1939
Oregon	Jason Lee	1953	John McLoughlin	1953
Pennsylvania	Robert Fulton	1889	John Peter G. Muhlenberg	1889
Rhode Island	Roger Williams	1872	Nathanael Greene	1870
South Carolina	John C. Calhoun	1910	Wade Hampton	1929
South Dakota	William H. H. Beadle	1938	Joseph Ward	1963
Tennessee	John Sevier	1931	Andrew Jackson	1928
Texas	Samuel Houston	1905	Stephen F. Austin	1905
Utah	Brigham Young	1950		
Vermont	Ethan Allen	1876	Jacob Collamer	1881
Virginia	Robert E. Lee	1934	George Washington	1934
Washington	Marcus Whitman	1953		
West Virginia	Francis H. Pierpont	1910	John E. Kenna	1901
Wisconsin	Robert M. La Follette, Sr.	1929	Jacques Marquette	1896
Wyoming	Esther Hobart Morris	1960		

Each person listed in the table has a biography in WORLD BOOK.

For example, Illinois has over 20 statutes of limitations. These statutes include limits of one year for libel and slander cases, two years for personal injury lawsuits, 10 years for cases involving written contracts, and 20 years for actions to recover land.

Statutes of limitations also apply to most crimes, limiting the time in which prosecutions must be brought. But serious crimes such as murder are not subject to statutes of limitations. HARRY KALVEN, JR.

STATUTE OF WESTMINSTER. See CANADA, GOVERNMENT OF (International Relations); COMMONWEALTH OF NATIONS (History).

STATUTORY LAW. See LAW (Statutes).

STAUBBACH is the highest waterfall in Switzerland and one of the highest in the world. It is 984 feet (300 meters) high. Staubbach is formed from racing torrents of melted snow that cascade into Lauterbrunnen Valley. Staubbach is outside the city of Lauterbrunnen. See also WATERFALL (chart). FRANKLIN CARL ERICKSON

STAUDINGER, *SHTOW ding ur,* **HERMANN** (1881-1965), a German chemist, pioneered in organic chemistry. He won the 1953 Nobel prize in chemistry for his study of "giant molecules." He developed and proved the idea that the atoms in many complex molecules are hooked together in long chains forming definite patterns. This opened the door to high-polymer chemistry and the development of plastics and synthetic fibers. Staudinger developed many synthetic materials, including artificial pepper and coffee aroma. He was born in Worms, Germany.

STAVANGER, *stah VAHNG ur* (pop. 82,467; met. area 124,254), is an important seaport on the southwest coast of Norway. It lies at the mouth of Bokna Fiord, which empties into the North Sea. For location, see NORWAY (map). Stavanger is noted for its merchant fleet, shipbuilding industry, and fish canneries. It was established about A.D. 1000 ARNE HAUGLAN

STAY OF EXECUTION. See REPRIEVE.

STE. ———. See SAINTE ———.

STEAK. See BEEF; MEAT.

STEAM, *steem,* is water which has been changed into a gas. Steam cannot be seen, for it is colorless. The cloud of vapor which we see beginning about an inch from the spout of a teakettle is not steam. The real steam is in the space that seems vacant, just outside the spout. The cloud we see is water that the cooler air has changed from gas form back into tiny water particles.

Steam can be formed by boiling or by evaporation. At sea level, water boils when it is heated to 100° C (212° F.), the *boiling point.* Water evaporates at lower temperatures. The steam caused by boiling is as hot as the boiling water. The steam caused by evaporation is not hot. Usually the word *steam* refers to hot steam.

When water reaches the boiling point, bubbles of steam begin to rise through it and escape into the air. The temperature will remain at the boiling point until all the liquid has become gas. It requires 100 calories of heat to raise one gram of water from the freezing point (0° C, or 32° F.) to the boiling point. To change the same gram of boiling water into steam, without raising its temperature, takes 540 calories of heat. This heat is called the steam's *latent heat.* It is released when the steam changes back to liquid water. Steam can cause more severe burns than boiling water because the steam condenses and releases its latent heat.

Homestead Industries, Inc.

Steam-Cleaning Equipment removes dirt and grease from machinery. A jet of steam blasts against the surface to loosen dirt. The steam then becomes water, which washes the dirt away.

Steam fills more space than the water from which it comes. At the moment when boiling stops, the gas is 1,670 times as great in volume as the former liquid. At this stage it is called *saturated steam.* If heated more, it takes up even more space. Then it is known as *superheated steam.* The steam engine is built around this principle. *Wet steam* supports particles of water still in liquid form. *Dry steam,* however, contains only gas. LOUIS MARICK

Related Articles in WORLD BOOK include:

Boiling Point
Evaporation
Steam Engine
Steam Hammer
Steam Shovel
Steamboat
Turbine (Steam Turbines)

STEAM ENGINE is any engine that is operated by the energy of expanding steam. The steam may be used to push pistons that turn the wheels of powerful locomotives. Or it may be used to spin huge turbines that drive electric generators and giant ocean liners. Large pumps, pile drivers, and many other kinds of powerful machines may also be driven by steam engines.

The development of the steam engine in the 1700's made modern industry possible. Until then, men had to depend on the power of their own muscles or on animal, wind, and water power. One steam engine could do the work of hundreds of horses. It could supply the power needed to run all the machines in a factory. A steam locomotive could haul heavy loads of freight great distances in a single day. Steamships provided safe, fast, dependable water transportation.

How Steam Engines Work

A steam engine does not create power. It uses steam to change the heat energy released by burning fuel into rotary or back-and-forth motion that can do work. Each steam engine has a *furnace* in which coal, oil, wood, or some other fuel is burned to produce heat energy. In atomic power plants, a reactor serves as the furnace and splitting atoms produce the heat (see Nu-

CLEAR REACTOR). Each steam engine also has a *boiler*. The heat from the burning fuel changes water into steam inside the boiler. The steam expands, or takes up many times the space of the original water. This energy of expansion can be used in two ways: (1) to push a piston back and forth, or (2) to spin a turbine.

Piston Steam Engines have pistons that slide back and forth in cylinders (see PISTON). Various systems of valves allow the steam to enter a cylinder and drive a piston first in one direction and then the other before they exhaust the used steam. These engines are often called *reciprocating* engines, because of the back-and-forth, or reciprocating, motion of their pistons. Steam hammers used to drive piles and to forge metal require this kind of motion (see FORGING; STEAM HAMMER). A locomotive, however, requires rotary motion to turn its wheels. This rotary motion is achieved by attaching a crankshaft to the ends of the pistons. In some types of reciprocating steam engines, called *compound engines*, the steam may flow through as many as four cylinders and operate four pistons.

Steam Turbines produce a rotary motion. A steam turbine has many sets of bladed wheels mounted on a long shaft. The steam enters at one end and spins the bladed wheels as it gushes past them. Steam turbines are used to turn electric generators and ship propellers.

History

Hero, a scientist who lived in Alexandria, Egypt, described the first known steam engine in 120 B.C. The engine consisted of a small, hollow globe mounted on a pipe running to a steam kettle. Two L-shaped pipes were fastened to opposite sides of the globe. When steam rushed out of the two L-shaped pipes, it caused the globe to whirl (see JET PROPULSION [picture, The First Jet Engine]). This engine, however, performed no useful work, and hundreds of years passed before the first successful steam engines were developed during the 1600's.

The First Steam Engines operated on the ability of steam to *condense* back into a liquid rather than on its ability to expand. When steam condenses, the liquid takes less space than the steam. If this condensing takes place in a sealed *vessel*, or container, a partial *vacuum*, or sucking action, is created that can do useful work.

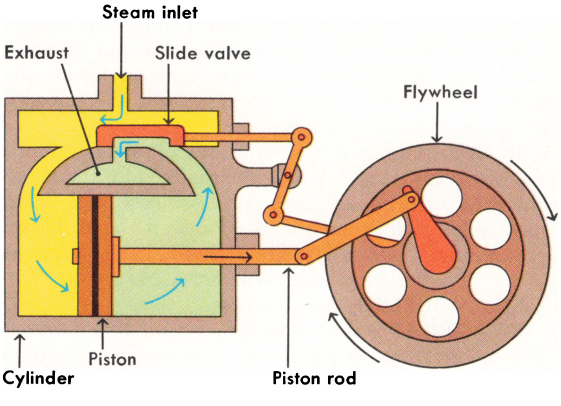
In 1698, Thomas Savery (1650-1715), an Englishman, patented the first practical steam engine, a pump to drain water from mines. Savery's pump had no moving parts other than valves operated by hand. These were turned to let steam enter a sealed vessel. Cold water was poured on the vessel to chill it and condense the steam. Then a valve was opened so the vacuum in the vessel could suck water up a pipe.

In 1712, Thomas Newcomen (1663-1729), an English blacksmith, invented another steam-engine pump for mines. Newcomen's engine had a large horizontal beam balanced in the middle like a seesaw. A piston which fitted into a cylinder hung from one end of the beam. When steam was let into the cylinder, it forced the piston up, lowering the other end of the beam. Cold water was then sprayed into the cylinder, the steam condensed, and the vacuum sucked the piston down again. This raised the other end of the horizontal beam. This end of the beam was attached to the piston of a pump in a mine.

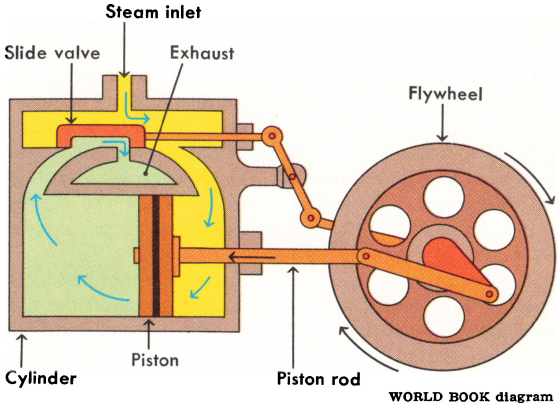
Watt's Engine. When James Watt began his experiments in 1763, the Newcomen engine was the best known. It set Watt to thinking, because it used an enormous quantity of steam and therefore a large amount of fuel. Watt saw that the alternate heating and cooling of the cylinder wasted much heat. He invented an engine in which the condenser and the cylinder were separate. The cylinder always remained hot. This saved three fourths of the fuel cost, because none of the steam was lost through condensation by entering a cold cylinder.

Watt took out his first patent on a steam engine in 1769, and continued to make improvements in his engines. Perhaps his most important improvement was the use of the *double-action* principle. In engines based on this principle, the steam is used first on one side of the piston, then on the other side. Watt also learned to shut

HOW A STEAM ENGINE WORKS

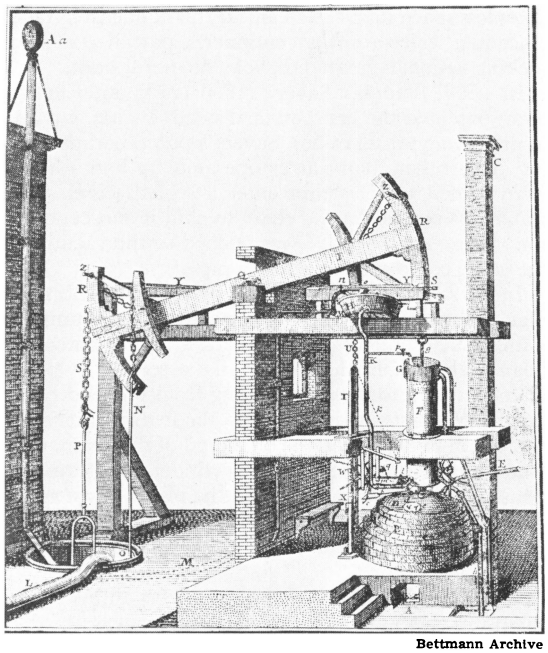


Steam operates the engine by pushing first on one side of the piston and then on the other. A slide valve directs the steam from side to side. In the diagram above, steam enters from the left side of the cylinder and forces the piston to the right. As the piston moves, the piston rod turns the flywheel half a turn.



WORLD BOOK diagram

When the piston reaches the right side of the cylinder, above, the slide valve moves and directs the steam behind the piston again. The steam forces the piston to the left. The piston rod then pulls the flywheel around to complete one turn. Steam in the left side of the cylinder escapes through the exhaust.



Bettmann Archive

Thomas Newcomen's Steam Engine drove a pump that removed water from mines. This bulky engine of the early 1700's turned only a fraction of the energy it received into useful work.

off the steam when the cylinder was only partly filled. This allowed the expansion of the steam already in the cylinder to complete the piston's stroke. Many persons mistakenly believe that Watt invented the steam engine. But he only improved it. He reduced the cost of operating *condensing* engines and made it practical to use these engines for other kinds of work than pumping.

Modern Steam Engines. The main improvement in the years after Newcomen and Watt was to develop engines capable of using high-pressure steam. Watt never experimented in the use of high-pressure steam, because he feared an explosion. The pressures in his engines were not much greater than air pressure, or about 15 pounds per square inch (1 kilogram per square centimeter). Then, in the late 1700's and early 1800's, an Englishman named Richard Trevithick designed and built the first high-pressure steam engines. One of his first engines operated under 30 pounds (2.1 kilograms) of pressure. By 1815, Oliver Evans, an American, had built an engine that used 200 pounds (14 kilograms) of steam pressure. Today, many engines use steam under a pressure of more than 1,000 pounds per square inch (70 kilograms per square centimeter).

Other improvements made in steam engines included the development of the compound engine, and the use of *superheated* steam. In superheating, the temperature of the steam is raised above 700° F. (371° C) without increasing the pressure. This helps keep the incoming steam from condensing on the surfaces of the piston cylinder, because superheated steam does not cool so quickly as ordinary steam. In the late 1800's, the invention of steam turbines marked another big improvement in steam engines. Steam turbines provided an economical source of power to turn electric generators, and to drive the propellers of steamships. Otto A. Uyehara

Related Articles in World Book include:

Corliss, George H.	Newcomen, Thomas
Governor	Ship
Evans, Oliver	Steam
Industrial Revolution (The Steam Engine)	Stevens (family)
Invention (picture)	Trevithick, Richard
Locomotive	Turbine (Steam Turbines)
	Watt, James

STEAM FITTER is a worker who installs and repairs the network of pipes needed in heating, air conditioning, refrigeration, and similar systems. He works with pipes made of various materials, and connects them to such equipment as furnaces, radiators, boilers, and cooling devices. Installing large systems requires precise measurements and the steam fitter may use blueprints to guide him in his work. In smaller installation jobs and repair work, the steam fitter frequently relies on his experience to place the pipes. Candidates usually serve a five-year apprenticeship or attend a trade school to become *journeymen* (experienced) steam fitters.

STEAM HAMMER is a power-driven hammer which is used to make heavy forgings. The hammer head is raised by the pressure of steam which is admitted into the lower part of the cylinder. When the hammer reaches the desired height, the steam is released and the hammer falls. Steam admitted into the upper part can be used to increase the speed of the fall. The speed with which the hammer is released also determines its force.

Steam hammers vary in weight from 100 pounds (45 kilograms) to 100 short tons (91 metric tons). They can be controlled so perfectly that a giant hammer head can descend with crushing force, or crack a nut without harming the kernel.

Steam drop hammers are raised like ordinary steam hammers. But they differ from other steam hammers in that they fall by their own weight. The steam hammer was invented by the Scottish engineer and manufacturer James Nasmyth in 1839. Arthur C. Ansley

See also Forging; Nasmyth, James; Trip Hammer.

STEAM HEATING. See Heating (Central Heating; illustration).

STEAM SHOVEL is a large *excavating* (digging) machine that is powered by steam. It has a large iron or steel scoop with teeth along the front edge. The bottom of the scoop has a hinge, so it can swing open and release its load. The scoop works from a beam that can be moved in any direction. An operator lowers the scoop to the ground and drives it forward and upward, scooping up earth and rock.

In 1838, William S. Otis of Massachusetts developed the first steam shovel. It dug the roadbed for the Western Railroad in Massachusetts. Engineers used steam shovels for projects such as the Panama Canal. Diesel power shovels have now replaced them. Robert G. Hennes

See also Building and Wrecking Machines.

STEAM TURBINE. See Turbine.

STEAMBOAT is a term used for steam-driven vessels that sail on rivers. It also refers to the smaller vessels on lakes or in the coastal waters of the sea. *Steamship* is used for large vessels such as those sailing on the open sea. In 1787, John Fitch demonstrated the first workable steamboat in the United States. The first financially successful steamboat was Robert Fulton's *Clermont*. In 1807, it steamed the 150 miles (241 kilometers) up the

Hudson from New York City to Albany in 32 hours. Steamboats carried passengers on the great rivers before the development of railroads and other faster or more efficient means of transportation. Steamships are still used in many parts of the world. ROBERT H. BURGESS

Related Articles in WORLD BOOK include:

Clermont	Roosevelt, Nicholas J.
Fitch, John	Ship
Fulton, Robert, with picture	Yukon River (picture)

STEAMING. See COOKING (Methods).

STEAMSHIP. See SHIP; STEAMBOAT.

STEARIC ACID, *stee AR ik*, is a valuable organic fatty acid that comes from many animal and vegetable fats and oils. The acid gets its name from the Greek word *stear*, which means *tallow*.

Stearic acid is prepared commercially by treating animal fats with water at high temperature and at high pressure. It is used for softening rubber, and also in manufacturing wax candles, cosmetics, and soaps.

Stearic acid is a waxy solid that melts at a temperature of about 70° C (158° F.). Its chemical formula is $CH_3(CH_2)_{16}COOH$. JOHN E. LEFFLER

See also FAT; ACID.

STEARIN, *STEE uhr ihn*, is a combination of stearic acid and glycerol. Chemically, stearin is an intricate compound of carbon, hydrogen, and oxygen. It is the chief ingredient of mutton and beef fat, and certain vegetable fats such as palm oil. When these substances are boiled, the stearin is crystallized into pearly, waxlike scales which have neither taste nor odor. Stearin is boiled with alkali to form soap. The stearic acid combines with the alkali, and the glycerol is separated as a by-product of the soapmaking. Stearin also yields an oil which is used in making some margarines. See also GLYCEROL; STEARIC ACID. LEONE RUTLEDGE CARROLL

STEATITE. See SOAPSTONE.

STEDMAN, EDMUND CLARENCE (1833-1908), was an American poet and journalist. He became a respected literary critic for such books as *Victorian Poets* (1875), *Poets of America* (1885), and *The Nature and Elements of Poetry* (1892).

Stedman was coeditor of Edgar Allan Poe's works in 10 volumes (1894-1895) and of the 11-volume *Library of American Literature* (1889-1890). Stedman encouraged the American public's taste for the genteel and idealistic, and he promoted interest in American literature.

Stedman was born in Hartford, Conn. He entered Yale University, but left school to serve as a war correspondent for *The* (New York) *World* during the Civil War. Stedman also operated a prosperous brokerage business in New York City. HARRY H. CLARK

STEEL. See IRON AND STEEL; ALLOY.

STEEL GUITAR. See HAWAII (Dancing and Music).

STEELE, SIR RICHARD (1672-1729), an Irish-born writer, created the popular journalistic essays that were published as *The Tatler*. He also collaborated with Joseph Addison in writing the essays published as *The Spectator*.

The Tatler (1709-1711) dealt in a humorous, good-natured way with family life, the theater, and literature. Steele tried to inform and entertain his readers, especially women, and to develop their taste. Steele did most of the writing in *The Tatler*, though Addison helped him. Addison contributed more essays to *The Spectator* (1711-1712) than his friend did. Steele was a frank, warm person, and his essays are livelier than Addison's (see ADDISON, JOSEPH). Steele later published several less successful series of essays. He also wrote four comic plays. The first play, *The Funeral* (1701), became very popular. His last play, *The Conscious Lovers* (1722), was an example of sentimental comedy, which flourished in English drama during the 1700's.

Steele was born in Dublin. In 1684, he entered the Charterhouse School in London, where he formed his long friendship with Addison, a fellow student. Steele went to Oxford University in 1689, but left without a degree to join the army. He served several terms in Parliament beginning in 1713. He was knighted in 1715. THOMAS H. FUJIMURA

STEELHEAD. See TROUT.

STEELWORKERS OF AMERICA, UNITED (USWA), is one of the largest labor unions in the United States. It is affiliated with the American Federation of Labor and Congress of Industrial Organizations (AFL-CIO). It has locals throughout North America. Its members work in the iron, steel, aluminum, and nonferrous metal industries. For membership, see LABOR (table).

The union was founded in 1936 as the Steel Workers Organizing Committee (SWOC) of the CIO. The Amalgamated Association of Iron, Steel, and Tin Workers became part of the SWOC in 1936. The present name was adopted in 1942. Since then, four other unions have merged with the USWA. They are the CIO Aluminum Workers of America, in 1944; the International Union of Mine, Mill and Smelter Workers, in 1967; the United Stone and Allied Products Workers of America, in 1970; and the Allied and Technical Workers, District 50, in 1972. The USWA publishes a monthly newspaper, *Steel Labor*. Headquarters are at 5 Gateway Center, Pittsburgh, Pa. 15222.

Critically reviewed by UNITED STEELWORKERS OF AMERICA

STEENBOK. See STEINBOK.

STEEPLE is a spire, or spire and tower, usually placed atop such buildings as a church or temple. The tower often contains bells, and is sometimes called a *campanile*.

See also CAMPANILE; CATHEDRAL (pictures); MASSACHUSETTS INSTITUTE OF TECHNOLOGY (picture); SPIRE.

STEEPLECHASING is the sport of horse racing over obstacles. Races are described as being *over brush*, *over timber*, or *over hurdles*, depending on the obstacles used. Jockeys ride thoroughbred horses at breakneck speed in steeplechases. Steeplechasing originated in England, and is the outgrowth of fox-hunting on horseback. The name comes from races hunters staged across country to "yonder church steeple." Organized U.S. steeplechasing began shortly after the Civil War. In addition to races at the major tracks, steeplechase meetings are held by fox-hunting clubs. JOHN E. COOPER

STEEPWATER. See CORN (Processing Corn).

STEER. See CATTLE.

STEERING. See AIRPLANE (Flying an Airplane); AUTOMOBILE (The Steering System); NAVIGATION.

STEFAN-BOLTZMANN LAW. See BOLTZMANN, LUDWIG.

STEFANSSON, *STEF'n s'n*, VILHJALMUR (1879-1962), an Arctic explorer and author, emphasized that the Arctic region is of great military and strategic importance. He argued that the region is "warm and

friendly," and that it should be settled and developed.

Stefansson was born in Arnes, Man., and attended the University of North Dakota, the University of Iowa, and Harvard University. In 1905, he became a member of an archaeological expedition to Iceland. Between 1913 and 1918, he led an expedition which explored Canadian and Alaskan Arctic regions.

During World War II, Stefansson served as an adviser to the U.S. Army and Navy. He became Arctic and Antarctic consultant to Dartmouth College in 1947. Later, he moved his 35,000-volume polar library to Dartmouth. He wrote many books, including *The Arctic in Fact and Fable* (1945), *Not by Bread Alone* (1946), and *The Fat of the Land* (1956). WILLIAM R. WILLOUGHBY

STEFFENS, LINCOLN (1866-1936), was an American author, editor, lecturer, and reformer. He was one of a group of writers known as *muckrakers* because their magazine articles from about 1902 to 1909 exposed corruption in government, business, and labor. Starting in 1902 with an exposé of crooked political practices in St. Louis, Steffens went on to write about conditions in many U.S. cities and states.

Steffens was born in San Francisco, and studied at the University of California and in Europe. He began his career with the *New York Commercial Advertiser*. He soon joined *McClure's Magazine*, and there wrote the articles that made him famous. Later, he wrote for the *American Magazine* and *Everybody's Magazine*. He published his *Autobiography* in 1931. JOHN TEBBEL

STEGOSAURUS. See DINOSAUR (Bird-Hipped).

STEICHEN, *STY kun*, **EDWARD** (1879-1973), was an American photographer. He studied painting, but became interested in photography as an art. In World War I, Steichen took charge of aerial photography for the American Expeditionary Force. During World War II, he headed a U.S. Navy aviation photographic unit. Steichen was director of the department of photography of the Museum of Modern Art in New York City from 1947 to 1962. In 1955, he organized the well-known photographic exhibit, *The Family of Man*, at the museum. Steichen received the Presidential Medal of Freedom in 1963. Eduard Jean Steichen was born in Luxembourg. He moved to the United States in 1882. BEAUMONT NEWHALL

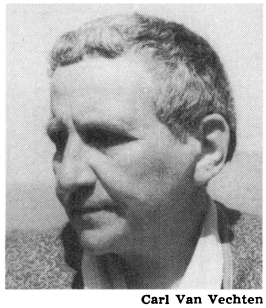
See also PHOTOGRAPHY (Photography for Everyone).

STEIG, *styg*, **WILLIAM** (1907-), an American cartoonist and children's author, won the 1970 Caldecott medal for *Sylvester and the Magic Pebble*. This story tells about a donkey named Sylvester and his adventures after he finds a magic pebble that can grant wishes. Steig wrote and illustrated the story.

Steig was born in New York City. He began his career in 1930 as a cartoonist and has contributed cartoons to many magazines, particularly *The New Yorker*. His other children's books are *Roland the Minstrel Pig* (1968) and *C D B!* (1968).

STEIN, GERTRUDE (1874-1946), was an American author who introduced a unique style of writing. She influenced many writers—among them Sherwood Anderson and Ernest Hemingway—who were trying to develop new ways to express themselves.

In her writing style, Stein repeated basic words. Her style is exemplified by her statement, "A rose is a rose is a rose." She felt that such repetition of words helped communicate the feelings they expressed. Stein believed that punctuation and difficult words distracted the reader from these feelings, and so she used little punctuation and simple words. In her fiction, she placed more importance on revealing the characters' feelings than on telling a story.



Carl Van Vechten

Gertrude Stein

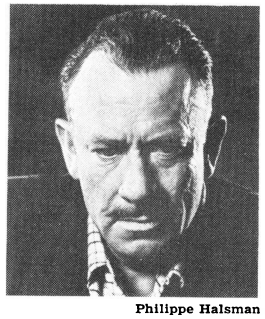
Stein was born in Allegheny, Pa., and graduated from Radcliffe College. She studied under the philosopher William James, and his teaching strongly influenced the writing style that she later developed. In 1903, Stein settled in Paris. Her apartment became a gathering place for many writers, musicians, and painters. Stein was one of the first persons to realize the importance of various experimental movements in painting. She encouraged such artists as Henri Matisse and Pablo Picasso and became an art critic and collector.

Stein's best-known book is *The Autobiography of Alice B. Toklas* (1933). She wrote it about herself from the viewpoint of Alice B. Toklas, her friend and secretary. Stein's other works include *Three Lives* (1909), a book of stories; and *Lectures in America* (1935), a collection of lectures on literature, painting, and music. She wrote the text for two operas composed by Virgil Thomson, *Four Saints in Three Acts* (1934) and *The Mother of Us All* (1947). MARCUS KLEIN

STEINBECK, JOHN (1902-1968), an American author, won the 1962 Nobel prize for literature. Steinbeck became famous for his novels about poor, oppressed California farmers and laborers. His most famous novel, *The Grapes of Wrath*, won the 1940 Pulitzer prize.

John Ernst Steinbeck was born in Salinas, Calif., and the Salinas area provides the setting for most of his fiction. Steinbeck's first novel, *Cup of Gold*, appeared in 1929. *Pastures of Heaven* (1932), his next book, is a collection of related stories. It portrays the people of a farm community near Salinas and their love of the land.

Critics gave Steinbeck serious attention for the first time following the publication of *Tortilla Flat* (1935). This novel vividly describes the life of migrants and poor farmers. *In Dubious Battle* (1936) deals with violent labor strikes in California during the 1930's. The book shows Steinbeck's liberal political views in its sympathetic treatment of the strikers.



Philippe Halsman

John Steinbeck

Steinbeck continued to express his liberal views in *Of Mice and Men* (1937) and *The Grapes of Wrath* (1939). Both these novels show how man struggles for survival in a hostile social environment.

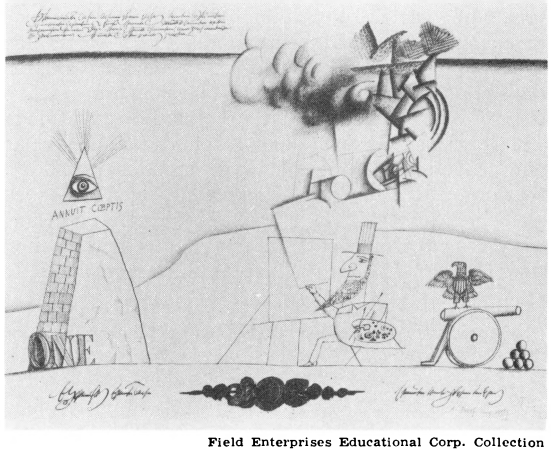
In *The Grapes of Wrath*, Steinbeck told about the poor Oklahoma farmers,

called *Okies*, who migrated to California during the Great Depression of the 1930's. The novel relates how the Joad family loses its farm through a bank foreclosure. The family then makes the difficult journey to California to start a new life. Steinbeck tells how the police and various employers in California mistreat the Joads and other migrant families. Critics at first considered *The Grapes of Wrath* a story of the economic crisis of the 1930's. But years later, critics realized that it portrays the search of all people for human dignity.

Most critics believe Steinbeck's later books rank below his fiction of the 1930's. Perhaps his best-known later novel is *East of Eden* (1952), a symbolic story about the need for brotherhood. His other later novels include *Sweet Thursday* (1954) and *The Winter of Our Discontent* (1961). In *Travels with Charley* (1962), Steinbeck described a journey across the United States with his pet poodle. JOSEPH N. RIDDEL

STEINBERG, SAUL (1914-), is an artist noted for his small-scale pen-and-ink drawings. His work is satirical and full of unexpected images and ideas. He became noted for funny drawings that had no captions or explanations. In many of them, figures utter "words" indicated by fantastic forms coming from their mouths.

Steinberg likes to draw parades, city crowds, strange animals, railroad stations, and drum majorettes. Some of his drawings of musicians are on music paper. He sometimes uses graph paper as a background and also



Field Enterprises Educational Corp. Collection

Steinberg's *Sam's Art* shows how the artist uses sharp line and an unusual combination of images to make witty comments about modern life. Much of his work appears in *The New Yorker* magazine.

makes documents resembling diplomas or certificates in which the writing is decorative but illegible. Steinberg was born in Rîmnicu Sărat, Romania. He came to the United States at the age of 28. ALLEN S. WELLER

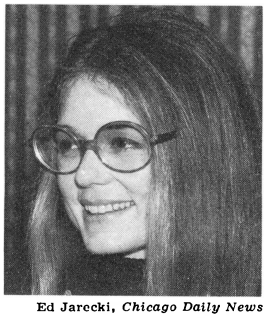
STEINBERG, WILLIAM (1899-), is a noted symphony orchestra and opera conductor who directs the Pittsburgh Symphony Orchestra. Steinberg is best known for his interpretations of romantic works (see ROMANTICISM [Romanticism in Music]).

Hans Wilhelm Steinberg was born and educated in Cologne, Germany. He conducted at opera houses in Frankfurt and in Prague, Czechoslovakia. Steinberg, a Jew, fled Nazi persecution about 1936. He came to the United States in 1938 to be assistant conductor of the National Broadcasting Company Symphony Orchestra. He became director of the Buffalo Philharmonic in 1945 and developed it into an important orchestra. In 1952, Steinberg became conductor of the Pittsburgh Symphony Orchestra. From 1969 to 1972, he directed both the Boston Symphony Orchestra and the Pittsburgh Symphony Orchestra. Steinberg became a United States citizen in 1944. KEITH POLK

STEINBOK, *STINE bahk*, or STEENBOK, is a small antelope that lives in southern and east-central Africa. Its name, taken from the Dutch, means *stone buck*. It has a reddish or pale brownish coat above, and is white below. It stands about 22 inches (56 centimeters) high. Males have straight slender horns seldom more than 4 to 5 inches (10 to 13 centimeters) long. Females are hornless. Steinboks live in dry grassland, but they can sometimes be found in open woodland.

Scientific Classification. The steinbok is a member of the bovid family, *Bovidae*. The common steinbok is genus *Raphicerus*, species *R. campestris*. VICTOR H. CAHALANE

STEINEM, GLORIA (1934-), is a writer and a leading supporter of the women's liberation movement in the United States. She has campaigned for women's rights in employment, politics, and social life. In 1972, Steinem founded *Ms.*, a magazine published and edited by women. *Ms.* tells women about career opportunities and meaningful ways of life.



Ed Jarecki, *Chicago Daily News*

Gloria Steinem

In 1971, Steinem helped found the National Women's Political Caucus, which encourages women to seek political office and to work for women's rights laws. That same year, she helped establish the Women's Action Alliance, which fights discrimination against women.

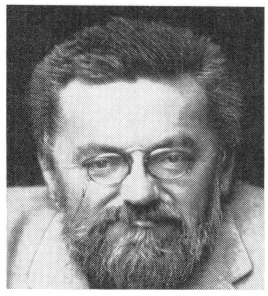
Steinem was born in Toledo, Ohio, and graduated from Smith College in 1956. She worked as a magazine and television writer before joining the women's liberation movement in 1968. CYNTHIA FUCHS EPSTEIN

STEINHEIM MAN. See SWANSCOMBE MAN.

STEINMETZ, CHARLES PROTEUS (1865-1923), was a German-born mathematician and engineer. He is best known for his development of the theory of alternating currents and for his experiments with "man-made lightning." The disadvantages of poverty, political misfortune, and a crippling deformity did not prevent him from becoming a scientific genius.

Steinmetz established his reputation in the American scientific community in 1892. He wrote a paper which contained an analysis of *hysteresis loss*, a magnetic effect peculiar to alternating current. He was soon invited to join the newly founded General Electric Company, where he spent the remainder of his career in research on electricity. Out of his laboratory, where for some years he lived as well as worked, came many experimental discoveries and inventions.

STEINWAY, HENRY ENGELHARD



Brown Bros.

Charles Steinmetz

Steinmetz was born in Breslau, Germany (now Wrocław, Poland). He fled the country in 1888, just before receiving a Ph.D. from Breslau University. He had been threatened with arrest for socialist activity. He came to the United States in 1889. He taught electricity at Union College in Schenectady, N.Y., and wrote several books on electrical theory. ROBERT P. MULTHAUF

STEINWAY, HENRY ENGELHARD (1797-1871), was a German-born piano maker who founded the Steinway & Sons piano company. Steinway established his firm in New York City in 1853, about three years after he immigrated to the United States. Steinway pianos are famous for their high quality.

In 1855, Steinway introduced the first successful piano with an interior cast-iron frame and a string arrangement called the *overstrung scale*. This arrangement had bass strings that stretched diagonally across the other strings. The frame and diagonal strings greatly improved the sound of a piano and have been used in nearly all pianos made since the 1850's.

Steinway was born near Seesen, in what is now West Germany. His real name was Heinrich Engelhard Steinweg. He received training as a cabinetmaker but began to make pianos in the 1830's. BARRY W. POULSON

STELLER'S SEA COW. See SEA COW.

STELLITE. See COBALT.

STEM is the central part of a plant. It supports the leaves, flowers, and fruits. The largest stems are the trunks of the sequoia trees of California.

Most stems have special structures which make them semirigid frameworks. In annual herbs, the ordinary cells of the stem usually fill with watery sap. When the stem loses its water, it wilts and is much less rigid. All woody stems and the stems of some herbs have special supporting cells besides the ordinary cell walls of cellulose. These special cells are known as *tracheids* and *fibers*.

The stem also furnishes channels for carrying sap between the roots and leaves. The roots absorb minerals and water from the soil, and the leaves manufacture food. Conducting cells and the supporting cells make up a great part of the stem. Sometimes the same cells carry on both functions.

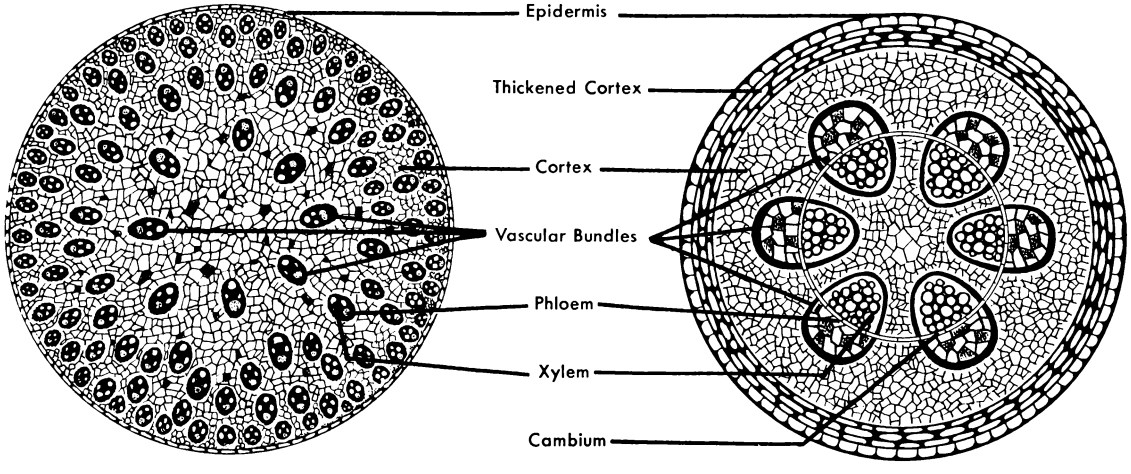
Water and minerals move up the stem through the tracheids and cells known as *vessels*. These cells, along with certain others, make up a tissue called *xylem*. Dissolved foods, such as sugars and proteins, travel through cells known as *sieve tubes*. Sieve tubes and other cells form a tissue called *phloem*. Many plants have a third tissue, the *cambium*. It is located between the xylem and phloem. The cambium produces new layers of xylem toward the outside of the stem and phloem toward the inside of the stem, usually each year.

Cross Section of the Stem. There are two common arrangements of xylem and phloem in the stem. One type is found in monocotyledonous plants, such as corn, bamboo, and grass. These plants have no cambium. The xylem and phloem form bundles in the shape of strands running the length of the stem. The second type occurs in dicotyledonous plants, such as oaks, elms, roses, and fruit trees. If a young stem of one of these plants is cut across, it shows bundles of cells, like the spokes of a wheel. In each bundle, all the phloem is on the outside, and the xylem inside. Older stems and trunks have a layer of phloem just inside the bark, and the rest of the stem is all xylem. The stem grows a new layer of xylem each year, thus forming the annual rings. The stems of full-grown dicotyledonous plants have an outer covering of bark. The bark contains cork layers that protect the tree and also prevent water loss.

Special Functions. Besides supporting the plant and carrying sap, some stems manufacture food. Others store food, and still others help produce new plants. In

CROSS SECTION OF A STEM

A cross section of a stem of a monocotyledonous plant, *left*, shows scattered vascular bundles. In a dicotyledonous plant, *right*, the bundles lie in a circle.



Monocotyledonous Plant **Dicotyledonous Plant**

perennial plants, food manufacture stops when the bark grows thick and corky, thus shutting out the light.

Leafless plants, like the cacti, have thick green stems that expose a broad surface to the light and air, and serve as leaves. The fleshy stem also holds water for the plant to use in time of drought. Many a thirsty traveler has drunk this reserve water to save his life.

Underground Stems. Some plants have underground stems. If these are long and slender they are called rootstocks. Examples are the May apple, Solomon's-seal, and mints. Other underground stems are the bulbs of the hyacinth and lily, and the tuber of the white potato. Stems like these hold large reserves of food, and keep the plant alive when it cannot make new food.

Reproduction by Stems. Many plants reproduce from portions of the stem. The most troublesome weeds are those which can grow again from their underground stems or rootstocks. Strawberry runners, lily bulbs, and potato tubers also produce new plants. A branch of the black raspberry will take root and form a new bush. Many plants, including the grapevine and currant, grow from stems that are broken off and planted. Such stems are called *cuttings*, or *slips*.

Life and Growth. In some plants, the stem lives a single year. In others, it may live indefinitely.

Different stems also have different rates of growth. The stalks of the sunflower and the giant ragweed may grow 10 to 12 feet (3 to 3.7 meters) in a season. Slender climbing stems often grow 40 feet (12 meters) in a single summer. Trees in dense forests get light and air by having most of their branches arranged at the tops of their very long trunks.

Uses of Stems. Man and the animals get much of their food from plant stems. Sugar, molasses, and syrup come from the sap in the stems of the sugar cane and the maple tree. The edible parts of potatoes and onions are underground stems. Asparagus, celery, and other vegetables are aerial shoots. Corn syrup is made from cornstalks. Common starch is often made from the potato, and sago is made from the starchy pith of the palm trunk. Perhaps most important of all is the use of woody stems as a building material. ARTHUR W. GALSTON

Related Articles in WORLD BOOK include:

Bark	Leaf (The Petiole)	Root
Bulb	Phloem	Sap
Corm	Plant	Tuber
Grafting	Rhizome	

STEM. See SHIP (table: Nautical Terms).

STENCIL, *STEN sul*, is a thin sheet of metal or other material, with lines and dots cut in it for the purpose of reproducing designs or letters. The stencil is placed on the surface of the material to be decorated or lettered. A brush or sponge is then wet with ink or paint and passed over the stencil. The stencil process serves as a quick method of marking packing boxes. It is also widely used to decorate curtains, bedspreads, furniture, and other household articles, as well as clothes and uniforms. Stencil designs also are used to decorate walls and for various types of signs. See also DUPLICATOR (The Stencil Duplicator). ARTHUR ZAIDENBERG

STENDHAL (1783-1842) is the pen name of MARIE HENRI BEYLE, one of the chief figures in the history of the French psychological novel. Stendhal was born in Grenoble. He served in the Napoleonic Wars, and Napoleon I became his great hero. Julien Sorel, the hero of Stendhal's masterpiece *The Red and the Black* (1831), lives a life of action and has great ambition, as Napoleon did. Stendhal's other great novel, *The Charterhouse of Parma* (1839), begins with Napoleon's defeat at the Battle of Waterloo, and tells of political intrigue in Italy.

In his writings, Stendhal was concerned basically with the search for happiness, which he believed could be achieved by the exercise of physical energy and will. Elements of realism and romanticism can be found in his work. He usually neglected other aspects of his novels in favor of analyses of the minute, changing emotional states of his characters.

Stendhal left three partly autobiographical novels unfinished at his death. They are *The Life of Henri Brulard*, *Lamiel*, and *Lucien Leuwen*. ROBERT J. NIESS

STENGEL, CASEY (1890?-), was one of baseball's great managers. He led the New York Yankees to seven world championships, including five straight from 1949 to 1953, and again in 1956 and 1958. Stengel's Yankees were also American League champions from 1955 through 1958, and in 1960. In 1962, Stengel became manager of the New York Mets. A hip fracture forced him to retire in 1965. He was elected to baseball's Hall of Fame in 1966. Born Charles Dillon Stengel in Kansas City, Mo., he became a professional ballplayer in 1910. During his long career, he also managed the Brooklyn Dodgers and Boston Braves. ED FITZGERALD

STENNIS, JOHN CORNELIUS (1901-), a Mississippi Democrat, has been a U.S. senator since 1947. He became chairman of the Senate Armed Services Committee in 1969 and plays a powerful role in shaping military budgets and influencing national security.

Stennis is a leading opponent of civil rights legislation. He charged in 1969 that "segregation in the schools exists in many major areas of the North to an equal extent, if not a greater extent than in the South."

Stennis was born near De Kalb, Miss., and graduated from the University of Virginia School of Law. He served in the Mississippi House of Representatives from 1928 to 1932 and was a Mississippi prosecuting attorney for five years before becoming a circuit court judge in 1937. In 1966, Stennis was named the first chairman of the Senate Committee on Standards and Conduct, often called the Senate Ethics Committee. WILLIAM J. EATON

STENOGRAPHY. See OFFICE WORK; SHORTHAND; SHORTHAND MACHINE.

STENOSIS. See RHEUMATIC FEVER.

STENOTYPE. See SHORTHAND MACHINE.

STEPHEN, *STEE vun* (1097?-1154), was an English king whose reign was so full of strife that it is called "The Anarchy." The cause was a disputed succession. Stephen was the son of Adela, daughter of William the Conqueror. The other claimant to the throne was Matilda, daughter of Henry I. Henry had persuaded his barons to pledge allegiance to her before he died in 1135. In 1153, Stephen was finally forced to recognize as his successor Matilda's son, Henry II, the first Plantagenet king (see PLANTAGENET). ROBERT S. HOYT

STEPHEN is the name of nine popes of the Roman Catholic Church. The church once listed 10 popes named Stephen. But in 1961, it dropped Stephen II from its list of popes. The numbers of the other Stephens were then moved up accordingly. The dates of their

reigns are given below. The Roman numerals in parentheses are the old numbers used to name the popes.

Stephen I, Saint (254-257)
Stephen II (III) (752-757)
Stephen III (IV) (768-772)
Stephen IV (V) (816-817)
Stephen V (VI) (885-891)
Stephen VI (VII) (896-897)
Stephen VII (VIII) (928-931)
Stephen VIII (IX) (939-942)
Stephen IX (X) (1057-1058)

Saint Stephen I (? -257) became famous because of his controversy with Saint Cyprian, bishop of Carthage. Cyprian insisted on rebaptizing converts who had received baptism from heretical ministers. Stephen opposed this practice, and established the enduring principle that baptism when correctly given, even by a non-Catholic, is valid and cannot be repeated. Stephen was born in Rome.

Stephen II (III) (? -757) was the first pope to travel to France. There, he sought the help of the Franks against the Lombards, who wanted to conquer Italy. He consecrated Pepin the Short and his sons as kings of the Franks in 754. In return, they became the protectors of the papacy. In 756, Pepin gave land in central Italy to Stephen that established the Papal States.

Stephen III (IV) (720?-772) excluded laymen from the election of the pope because of political interference by the Italian princes. He was born in Sicily.

Stephen IX (X) (1000?-1058) tried unsuccessfully to prevent the separation of the Eastern and Western churches. He succeeded Victor II as pope in 1057. Stephen was born in Lorraine. GUSTAVE WEIGEL and FULTON J. SHEEN

STEPHEN, GEORGE (1829-1921), BARON MOUNT STEPHEN, was a Canadian financier. He was one of the founders, as well as the first president, of the Canadian Pacific Railway. Stephen was born in Dufftown, Scotland. He went to Canada in 1850 and became a cloth manufacturer in Montreal. In 1876, he became president of the Bank of Montreal. In 1880, he became a leading member of the company that built the Canadian Pacific, Canada's first transcontinental railway. He moved to England in 1888. WILLIAM R. WILLOUGHBY

STEPHEN, SAINT, was the first Christian martyr. He was stoned to death outside Jerusalem some time after the Crucifixion (Acts 7:59).

Stephen was one of the seven church officers, or deacons, appointed by the apostles. The deacons were to look after the poor. Stephen was a deeply religious man, known for the miracles he performed and for his preaching. Stephen's enemies accused him of teaching disobedience to the customs and rules associated with the law of Moses. He was brought to trial before the high council of the Sanhedrin. Here he made a great speech in his own defense (Acts 7). He said he was not speaking against the sacred Law, but that instead those who attacked him were failing to obey the Law themselves. The mob became furious and attacked him. One witness to his death was Saint Paul, who was not yet converted to Christianity (Acts 8:1). The Roman Catholic Church and the Church of England observe Saint Stephen's Day on December 26. FREDERICK C. GRANT

STEPHEN F. AUSTIN STATE UNIVERSITY. See UNIVERSITIES AND COLLEGES (table).

STEPHENS, ALEXANDER HAMILTON (1812-1883), was vice-president of the Confederate States of America during the Civil War. He was opposed to secession, but he remained loyal to Georgia when the state left the Union in 1861. He served as a delegate to the Montgomery Convention which formed the Confederacy, and he was chosen vice-president of the new government. During the war, Stephens often disagreed with Jefferson Davis, president of the Confederacy, on questions of states' rights.

Brown Bros.

Alexander H. Stephens

In February, 1865, Stephens led an unsuccessful peace commission which met with President Abraham Lincoln at Hampton Roads (see HAMPTON ROADS CONFERENCE). After the war, he was arrested and imprisoned for six months at Fort Warren in Boston Harbor. Georgia elected him to the United States Senate in 1866, but Congress refused him his seat. He then wrote *A Constitutional View of the Late War Between the States* (1867-1870). Later, he wrote other books, and became editor of the Atlanta *Southern Sun* in 1871.

Stephens was again elected to Congress in 1872, and served 10 years. He was elected governor of Georgia in 1883, but he died a few months after taking office. Stephens was born near Crawfordville, Ga., and was educated at the University of Georgia. He had originally intended to become a minister, but he changed his mind, and studied law instead. In 1834, he was admitted to the bar, and two years later became a member of the Georgia state legislature. He opposed vigilance committees, and the "slicking clubs," which were the parent of the Ku Klux Klan. From 1843 to 1859, he served as a congressman from Georgia. Alexander Hamilton Stephens represents Georgia in Statuary Hall in Washington, D.C. W. B. HESSELTINE

STEPHENS, JAMES (1882-1950), was an Irish poet, novelist, and short-story writer. His work is sometimes humorous and playful and sometimes serious, but it is always imaginative and unusual. *The Crock of Gold*, a fantasy-novel, is probably his best-known book. It was first published in 1912. Stephens' interest in Irish folklore is apparent in much of his work, such as his *Irish Fairy Tales* (1920), a book for young people. He also wrote the books of verse *The Hill of Vision* (1912), *Strict Joy* (1931), and *Kings and the Moon* (1938). Stephens was born in Dublin. JOSEPH E. BAKER

STEPHENS COLLEGE. See UNIVERSITIES AND COLLEGES (table).

STEPHENSON is the family name of two British engineers, father and son. Their inventions helped create the British railway system.

George Stephenson (1781-1848) was called the *Founder of Railways*. His skill in repairing coal-hauling engines in the mines earned him the title of *Engine Doctor*. He finally decided to build a locomotive of his own. His second engine, *Puffing Billy* (1814), embodied his invention, the steam blast. This device increased the draft in the boiler. In turn, the fire became hotter and made steam of a higher pressure. His engine was so successful that it pulled heavy loads of coal for years. His locomotive, *The Rocket* (1829),

traveled at the then unheard-of speed of 30 mph (48 kph). It was a model for later steam locomotives.

Stephenson invented many useful things besides engines, including a miner's lamp, a fisherman's lamp, and an alarm clock. He became well known for building the Stockton and Darlington Railway from 1821 to 1825. Then he built the difficult Liverpool and Manchester Railway. Here he used his ideas for tunnels, grading, and bridges to make a level roadbed.

Stephenson was born in Wylam, near Newcastle. As a boy, he made models of engines of clay and sticks which later helped him work out some of his great projects. He was consulted on major railway projects in many countries, and spread his original ideas for safety and passenger comfort. With the wealth from his inventions and locomotive factory, he became a philanthropist. His night schools for miners, and libraries, music clubs, recreation rooms, and schools for miners' children, were as original in his day as were his inventions.

Robert Stephenson (1803-1859), the son of George Stephenson, was chiefly noted for the great bridges and viaducts he built. He invented the tubular bridge, and introduced the use of tubular girders in the construction of iron bridges. Stephenson built railways in Germany, Switzerland, Canada, Egypt, and India. Later, he became interested in politics, and served in the House of Commons from 1847 until 1859.

Stephenson was born near the coal mines at Willington Quay. He studied at the University of Edinburgh and went to South America as a mining engineer. He returned in 1827, and helped his father build *The Rocket*. From 1833 to 1838, Stephenson was chief engineer for the construction of the London and Birmingham Railway. This railway was the first to enter London. Stephenson lived in London. JOHN H. KEMBLE

See also LOCOMOTIVE (picture); ROCKET, THE.

STEPINAC, *STEP ih nack*, **ALOYSIUS CARDINAL** (1898-1960), a Yugoslav cardinal of the Roman Catholic Church, became a symbol of resistance to Communism after World War II. At that time, the Communist government of Marshal Tito determined to restrict organized religion in Yugoslavia. Stepinac was charged with aiding Germany and Italy during the war. He was tried in October, 1946, and sentenced to 16 years of hard labor. He was offered freedom if he would leave the country, but he refused. In 1951, he was released. Pope Pius XII made him a cardinal in 1953. Stepinac was born in Zagreb, Yugoslavia. He worked for the rights of the Croatian people in Yugoslavia. Stepinac became an archbishop in 1937. JOHN T. FARRELL and FULTON J. SHEEN

STEPPE, *stehp*, is an area covered chiefly by short grasses. Steppes are found in dry areas that have hot summers and cold winters. Most steppes receive an average of from 10 to 20 inches (25 to 51 centimeters) of rain a year—less rain than on a prairie, but more than on a desert. The interior regions of North America and Eurasia have large steppes. In North America, steppes cover most of the Great Plains from northern New Mexico to southern Alberta. In Russia, they extend from the southern Ukraine into central Asia.

Most steppe plants grow less than 1 foot (30 centimeters) high. They do not grow so dense as the tall grasses of prairies. Plants of the North American steppes include blue grama grass, buffalo grass, and small relatives of the sunflower. Until man began to farm those areas, many bison, jack rabbits, prairie dogs, pronghorns, and hawks lived there.

Today, man uses steppes to graze livestock and to grow wheat and other crops. Overgrazing and plowing have harmed some steppes. After a steppe has been plowed, strong winds may blow away the loose soil, especially during a drought. A combination of plowing, winds, and drought has caused severe dust storms on the Great Plains (see DUST BOWL). CLAIR L. KUCERA

STERE. See METRIC SYSTEM (table).

STEREO CAMERA. See CAMERA (Stereo Cameras; picture).

STEREOCHEMISTRY. See PLASTICS (table: Terms).

STEREOPHONIC SOUND. See PHONOGRAPH; HIGH FIDELITY (Stereophonic Hi Fi); SOUND (Stereophonic Sound).

STEREOSCOPE, *STEHR ee uh SKOHP*, is an optical viewing device that makes photographs seem to have three dimensions. An ordinary camera sees things only in a flat plane, and never in the round, the way our eyes usually see things. But two cameras set slightly apart can work like our eyes. They can photograph the same object at the same time. These two photographs are then mounted side by side and viewed through a combination of lenses and prisms called a *stereoscope*. The two views then enter the eyes without strain, and the resulting mental image appears to have three dimensions. Everything is seen in the round.

A stereoscope with a cabinet of pictures was once a common item. The old-style stereoscope consisted of a rack and handle, a slide, and a pair of screened lens-prisms. The present-day stereoscope is a plastic box with two viewing holes. One popular type has picture slides mounted in a cardboard or plastic disk.

Today, stereoscopes are employed extensively in aerial surveys to map out land elevations. Astronomers use a special type of stereoscope for finding small planets. It is possible to mount two stereophotographs side by side and view them without prisms. The effect is a good picture in the round, but it causes eyestrain.

In 1952, producers introduced "three-dimensional" motion-picture projection. Some types used a large, curved screen and a new kind of sound projection to produce a three-dimensional effect. Others used a stereoscopic principle. Persons watching the film wore special eyeglasses so that each eye saw only the view meant for it. The mental image that resulted had three dimensions. EDITH LILLIAN SMITH WEBSTER

See also EYE (Stereoscopic Vision); CAMERA (Stereo Cameras); POLARIZED LIGHT.

STEREOTYPING is the method of making metal plates for use in printing. In the process, workmen set the type and lock it into a steel *chase* (frame). Others brush the face of the type with a thin coating of oil. A prepared sheet of thick, composite paper, called *flong*, is laid on the type and beaten or pressed tightly against it. This sheet takes an impression of the face of the type or *cut* (picture) in the frame. The paper mold thus formed then goes into an oven and bakes until it becomes hard and dry. This mold, which is known as a *matrix*, or *mat*, is placed in a box face up. A workman pours melted stereotype metal, made up of tin, anti-

mony, and lead, over it. This hardens at once, forming a solid plate, and the page is printed from this.

Introduction of the stereotype process helped speed up newspaper printing. The stereotype plates used on small presses are flat. Those used on rotary presses for newspapers are in the form of half cylinders. It takes only about 15 minutes to make stereotype plates, and they are inexpensive compared to other printing plates. One matrix can produce a number of plates. Country newspapers get some of their subject matter from plants in cities which specialize in making plates and "mats." "Boilerplate" is the slang term for this material. Stereotyping is used mostly in printing newspapers, but it is also used to print magazines, catalogs, and inexpensive books. EUGENE M. ETTENBERG

See also ELECTROTYPING; TYPE.

STERILANT. See WEED (Herbicides).

STERILITY, *stuh RIHL uh tee,* refers to the inability to reproduce. It applies to all forms of life, from microorganisms to higher plants, animals, and man.

Some antibiotics, such as penicillin, interfere with the reproductive powers of disease-producing bacteria. This keeps the number of bacteria low, and enables the body to overcome disease.

A plant may be sterile because of imperfectly developed reproductive organs. If the stamens and pistils are imperfect or absent, the plant cannot reproduce. Sterility in animals results if the reproductive organs do not develop properly. Certain hybrid animals, such as the mule, cannot reproduce.

Sterility in human beings may have several causes. It may result from defects in the structure of the reproductive organs. Certain diseases affect the reproductive organs and may cause sterility. Improper balance of the hormones produced by the pituitary gland, the thyroid gland, the adrenal glands, and the sex glands may result in failure to produce eggs or sperm. Human beings may intentionally become sterile by undergoing surgical sterilization (see BIRTH CONTROL [Methods of Birth Control]). STUART ABEL

STERILIZATION, *STEHR uh luh ZAY shuhn,* in medicine and bacteriology, means the killing of germs. Germ killing helps to prevent infection and the spread of disease. Doctors and dentists sterilize their tools before they touch the human body. The bandages and many of the medicines we buy are sterilized before they are packed. Sterilization has been practiced only since the late 1800's. The English surgeon Joseph Lister introduced antiseptic, germ-killing methods into surgery.

Proper sterilization is done by fire, steam, heated air, or certain chemicals. Steam and heated air are the best, for they leave no foreign matter on the sterilized object. Fire is commonly used in the home to sterilize a needle with which to prick a blister or remove a splinter. Steam cabinets are often used to sterilize medical instruments. Heated dry air is used to sterilize oily medicines.

The word *sterilization* is also used to refer to surgical procedures that prevent a female from becoming pregnant or a male from fathering a child. For information on such surgical sterilizations, see BIRTH CONTROL (Methods of Birth Control). GEORGE L. BUSH

See also AUTOCLAVE; DISINFECTANT; GERMICIDAL LAMP; PASTEURIZATION; SOUND (Ultrasound).

STERLET. See STURGEON.

STERLING. See POUND STERLING.

STERLING COLLEGE. See UNIVERSITIES AND COLLEGES (table).

STERLING SILVER. See SILVER (Uses of Silver).

STERN. See SHIP (table: Nautical Terms).

STERN, ISAAC (1920-), is an American violinist known for his fine artistry. He made his debut with the San Francisco Symphony Orchestra when he was 11 years old. Later, he appeared with the Los Angeles Philharmonic Orchestra and toured the Pacific Coast in a concert series. Stern made his New York City debut in Town Hall in 1937 and played at Carnegie Hall in 1943. He was born in Kremeniecz, Russia, and was brought to the United States when he was a year old. DOROTHY DELAY

S. Hurok

Isaac Stern

STERN, OTTO (1888-1969), an American physicist, received the 1943 Nobel prize in physics. He showed that Louis Victor de Broglie's theory (that moving particles behave like waves) is also true of molecules, by observing their diffraction when a beam of hydrogen or helium struck a crystal. With Walther Gerlach, he developed a method of measuring the magnetic moments of atoms and then refined it to measure those of atomic nuclei. He was born in Sorau, Germany (now Żary, Poland), and came to the United States in 1933. G. GAMOW

STERNE, LAURENCE (1713-1768), was an English clergyman who suddenly became famous as the author of *The Life and Opinions of Tristram Shandy, Gentleman* (1760-1767).

Tristram Shandy is an unconventional novel of conversations and reminiscences rather than action. Tristram is only about five years old when the story ends. This is partly because the work was never finished, but mainly because Sterne was more interested in other characters —Tristram's family, their friends and servants. The book is lively and extremely witty. Its popularity reflects the growing regard for humor and laughter and for feeling and sentiment during that period. Tristram's Uncle Toby, the simple and good-hearted soldier, climaxed a long line of lovable but comic eccentrics in the literature of the 1700's.

The novel's conversations and incidents do not follow the usual time sequence. Sterne was influenced by the philosopher John Locke. Locke thought that at birth the mind is a blank tablet upon which ideas take form only through the association of experiences gained through our senses. Locke observed that we may sometimes associate ideas that are logically unrelated. These erroneous chains of ideas form the basis of the narrative development in *Tristram Shandy.* Although readers may at first be confused by the way Sterne jumps from one idea to another, the book eventually may seem closer to our own experience of life than more conventional novels. Its method anticipates the stream-of-consciousness novels of James Joyce and Virginia Woolf.

Sterne was born in Clonmel, Ireland. He suffered from tuberculosis, and made trips to the milder climate of southern France for his health. These trips inspired *A Sentimental Journey Through France and Italy* (1768). This is an unconventional travel book that tells more about Sterne's love affairs and passing reflections than about the places he visited. IAN WATT

STERNUM. See SKELETON.

STEROID, *STEHR oyd,* is a class of chemical compounds that are important in chemistry, biology, and medicine. They play a very important part in the body processes of living things. Steroids are produced naturally by plants and animals. They are also made commercially. Steroids include sterols, such as cholesterol; bile acids from the liver; adrenal hormones; sex hormones; and poisons in certain toads (see CHOLESTEROL; LIVER; GLAND).

All steroids are alike in basic chemical structure. But each steroid has a slightly different arrangement of molecules. Because of this difference, steroids have different effects on living things. In addition, individual organisms may react in different ways to the same steroid.

Steroids influence body *metabolism*, the process by which the body changes food into energy and living tissue. In plants, they help form certain vitamins and other important substances. Some steroids are used in medicine to treat diseases. *Digitalis* is one of the plant steroids, and is often used to treat heart failure (see DIGITALIS).

The Sex Steroids *estrogen* and *progesterone* are given off by the *ovaries* (female sex organs). These steroids are responsible for the female's smooth, soft skin; high-pitched voice; rounded hips; and the development of the breasts. *Contraceptive pills* (pills that help prevent pregnancy) contain powerful man-made forms of progesterone. Some of these pills also contain estrogen (see BIRTH CONTROL).

Androgens are sex steroids that are produced by the *testes* (male sex glands). Androgens are responsible for the male's beard, large muscles, and deep voice. These steroids may even influence certain personality traits such as aggressiveness, which is considered a male characteristic.

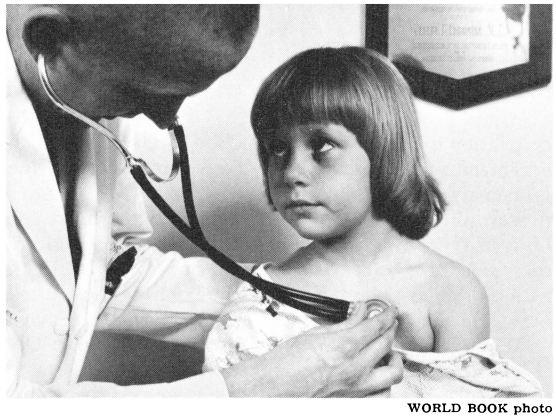
The Adrenal Steroids are present in both sexes. The *cortex* (outer layer) of the adrenal gland produces *cortisol*, *corticosterone*, and small amounts of *cortisone*. These steroids help regulate protein and carbohydrate metabolism. Other steroids from the adrenal cortex influence mineral and water balance of the body.

Doctors use adrenal steroids to reduce *inflammation* (redness and swelling from injury) and to treat arthritis, skin diseases, allergies, and many other diseases. If the adrenal glands are surgically removed, a person will die unless he receives treatments with steroids.

Scientists first obtained cortisone for commercial use from adrenal glands. Today, most of it is produced in laboratories by chemical methods. Many other kinds of steroids are made for different commercial uses in medicine.

The normal steroid secretion of the ovaries, testes, and adrenal glands is regulated by a small part of the brain called the *hypothalamus*. The hypothalamus controls the release of the powerful protein hormones *gonadotropins* and *adrenocorticotropic hormone* (ACTH) from the pituitary gland. These hormones cause the ovaries, testes, and adrenal glands to release their steroids. The steroids then affect other body parts and characteristics. GORDON FARRELL

See also HORMONE.



WORLD BOOK photo

A Stethoscope allows a physician to hear various sounds made by the heart, the lungs, and certain other organs.

STEROL. See VITAMIN (Vitamin D).

STEROPE. See PLEIADES.

STETHOSCOPE is a device physicians use to hear the sounds produced by certain organs of the body, such as the heart, lungs, intestines, veins, and arteries. The stethoscope picks up the sounds made by these organs and excludes other sounds.

The stethoscope consists of a body contact piece, which is placed against the body of the patient, and earpieces, which are placed in the ears of the physician. Hollow rubber tubing connects the body contact piece to the earpieces. Physicians use either a bell, diaphragm, or bell-diaphragm combination body contact piece. The bell type of contact piece picks up low sounds. The diaphragm type of contact piece allows the listener to hear higher sounds.

Before the invention of the stethoscope, the physician placed his ear next to the patient's body to hear the sounds made by the organs. René Laënnec, a French physician, made the first stethoscope from a hollow wooden tube in 1816. E. CLINTON TEXTER, JR.

See also LAËNNEC, RENÉ T. H.

STETSON, JOHN BATTERSON (1830-1906), was an American hat manufacturer and philanthropist. He went West in the early 1860's to regain his health, and used his knowledge of Western tastes and hatmaking to design his famous ten-gallon hat. He established a factory in Philadelphia in 1865, and became the leading hat manufacturer in America. Though he had no formal education, Stetson endowed a small academy in De Land, Fla., which later became Stetson University. He was born in Orange, N.J. JOHN B. MCFERRIN

STETSON UNIVERSITY. See UNIVERSITIES AND COLLEGES (table).

STETTIN. See SZCZECIN.

STETTINIUS, *stuh TIHN ih uhs,* **EDWARD RILEY, JR.** (1900-1949), was secretary of state under Presidents Franklin Delano Roosevelt and Harry S. Truman. When the national defense program was set up in 1940, Stettinius held key posts. From 1941 to 1943, he was the lend-lease administrator (see LEND-LEASE). As secretary of state in 1944 and 1945, he joined President Roosevelt at the Yalta Conference. He led the U.S.

delegation to the 1945 San Francisco Conference, which organized the United Nations. He became rector of the University of Virginia in 1946.

Stettinius was born in Chicago, and attended the University of Virginia. He became vice-president of the General Motors Corporation in 1931. In 1938, he took the post of chairman of the board of the United States Steel Corporation. HARVEY WISH

STEUBEN, *STOO bun,* or *SHTOY bun,* **BARON VON** (1730-1794), FRIEDRICH WILHELM LUDOLPH GERHARD AUGUSTIN, was a German soldier who helped the American colonists against England during the Revolutionary War.

Von Steuben sailed to America in 1777. On Benjamin Franklin's recommendation, General George Washington sent him to Valley Forge to train the raw colonial troops. As a major general, he led troops against the British at Monmouth and Yorktown. After the war, he became a United States citizen.

Von Steuben was born in Magdeburg, Germany. He joined the Prussian Army and later became aide-de-camp to King Frederick the Great. ROBERT G. L. WAITE

STEUBEN GLASS. See GLASSWARE (Present-Day Art Glass).

STEUBENVILLE, COLLEGE OF. See UNIVERSITIES AND COLLEGES (table).

STEUNENBERG, FRANK. See IDAHO (Early Statehood).

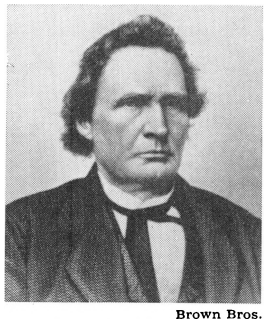
STEVENS was the family name of two American engineers, father and son, who helped to develop the steam engines.

John Cox Stevens (1749-1838) pioneered in developing steam transportation in the United States. His boat *Phoenix,* which operated on the Delaware River to Philadelphia in 1809, became the world's first seagoing steamboat.

Stevens experimented in the use of steam engines on railways. A railway on his estate carried the first American-built steam locomotive. Stevens was born in New York City. ROBERT W. ABBETT

Robert Livingston Stevens (1787-1856) became a leader in steamship design and construction. Stevens invented protective devices and was among the first to use high-pressure steam engines in ships. For railroads, he invented the T-shaped rail and the hook-headed railroad spike.

Stevens was born in Hoboken, N.J. He first worked with his father, a rival of Robert Fulton in steamship construction. Robert Stevens also designed an armored ship that was used by the United States government. ROBERT E. SCHOFIELD



Brown Bros.

Thaddeus Stevens

STEVENS, ISAAC INGALLS. See WASHINGTON (History).

STEVENS, THADDEUS (1792-1868), was an American statesman. He was one of the Republican leaders in Congress who favored harsh treatment for the South after the Civil War.

From 1859 to 1868, Stevens was the dominant figure in the House of Representatives. He urged emancipation of the slaves and confiscation of the planters' lands. He favored tariffs, banking laws, and railroad subsidies for Northern businessmen. He led the movement to impeach President Andrew Johnson.

Stevens was born at Danville, Vt., and was graduated from Dartmouth College. He practiced law for many years in Pennsylvania. In the state legislature, he championed public schools. He served from 1849 to 1853 in the U.S. House of Representatives, and opposed fugitive slave laws and other measures favorable to Southern interests. RICHARD N. CURRENT

STEVENS, WALLACE (1879-1955), was an American poet. He portrayed man as an earthbound creature without hope of an afterlife. As viewed by Stevens, man faces at every turn the seeming indifference of nature, the certainty of his own death, and his sense of the moral and physical decay occurring around him. Man is rescued from this potentially tragic situation through the use of imagination. Imagination can give meaning to the confusion of reality. It can also discover beauty in indifferent nature and ease the thought of death by marveling at the feeling of being alive. Stevens explored the virtues of the imaginative life in such relatively simple poems as "Sunday Morning" and "The Emperor of Ice Cream," and in such longer, more complex works as "The Man with the Blue Guitar" and "Esthetique du Mal."

Stevens had a unique writing style. His meaning and many of his words are difficult to understand. But his poems are also characterized by an extraordinary richness of language.

Stevens was born in Reading, Pa. His career was unusual in that he turned out his poetry while also succeeding as a lawyer and insurance executive. He was little known as a poet during his lifetime, but became a major influence on other poets after his death. His craftsmanship and his recognition of the moral responsibilities of poetry have been models to younger writers. His *Collected Poems* won the 1955 Pulitzer prize for poetry. CLARK GRIFFITH

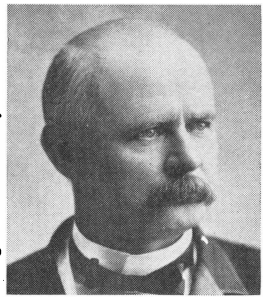
STEVENS DAM. See MUD MOUNTAIN DAM.

STEVENS INSTITUTE OF TECHNOLOGY. See UNIVERSITIES AND COLLEGES (table).

STEVENSON, ADLAI EWING (1835-1914), was Vice-President of the United States from 1893 to 1897 under President Grover Cleveland. He was the grandfather of Adlai E. Stevenson, the Democratic presidential nominee in 1952 and 1956. Stevenson was an inflationist in a sound-money administration. Largely for this reason, the public was never informed when Cleveland underwent an emergency operation during the business panic of 1893. His advisers feared the panic might increase if there seemed to be any possibility of Stevenson succeeding to the presidency.

Stevenson was nominated for the vice-presidency again in 1900 as the running mate of William Jennings Bryan. But the Democrats lost to William McKinley and Theodore Roosevelt. Stevenson also ran for governor of Illinois in 1908, but was defeated.

Stevenson served in a variety of appointive and elective offices. He was a member of the House of Representatives for two terms. As the first assistant postmaster general of the U.S. from 1885 to 1889, he



Chicago Historical Society

Adlai E. Stevenson (1835-1914)

Adlai E. Stevenson (1900-1965)

angered Republicans because he shifted jobs to Democrats. He was born in Christian County, Kentucky, and attended Illinois Wesleyan University. IRVING G. WILLIAMS

STEVENSON, ADLAI EWING (1900-1965), was the Democratic nominee for President of the United States in 1952 and 1956. Dwight D. Eisenhower defeated him both times. Stevenson's running mates were John J. Sparkman in 1952 and Estes Kefauver in 1956. Stevenson served as U.S. ambassador to the United Nations from 1961 until his death.

Stevenson was a grandson of Vice-President Adlai E. Stevenson. He was born in Los Angeles, Calif., on Feb. 5, 1900. After graduating from Princeton University, he studied law at Harvard and Northwestern universities. He worked on his family newspaper, the *Bloomington* (Ill.) *Daily Pantagraph*, and practiced law in Chicago. In 1933 and 1934, Stevenson held his first public office, serving as special counsel to the Agricultural Adjustment Administration. Later, during World War II, he was a special assistant to Secretary of the Navy Frank Knox, and led a United States mission on occupation policies in Italy. After the war, he became an alternate delegate to the United Nations.

In 1948, Stevenson was elected governor of Illinois by the largest plurality in the state's history. He was considered by many for his party's 1952 presidential nomination, but he refused to campaign. Nevertheless, the party nominated him after a dramatic convention struggle. During his campaigns, he became noted for his wit, speaking ability, and the high literary quality of his speeches. In 1952, his book *Major Campaign Speeches* was published. He also wrote and published *Call to Greatness* (1954), *What I Think* (1956), *Friends and Enemies* (1959), *Putting First Things First* (1960), and *Looking Outward: Years of Crisis at the United Nations* (1963). In 1970, his son Adlai III was elected to the U.S. Senate from Illinois. ARTHUR SCHLESINGER, JR.

STEVENSON, ROBERT (1772-1850), was a Scottish civil engineer noted as a builder of lighthouses. He built 23 lighthouses along the coast of Great Britain, and invented the flashing light now used in lighthouses throughout the world (see LIGHTHOUSE [The Light]). His most noted work is the Bell Rock Lighthouse, which he designed and built with John Rennie. The poet Robert Southey immortalized Bell Rock in his "Inchcape Rock." The lighthouse stands in the North Sea 11 miles (18 kilometers) from Dundee, Scotland. Stevenson was born in Glasgow. The author Robert Louis Stevenson was his grandson. ROBERT W. ABBETT

STEVENSON, ROBERT LOUIS (1850-1894), was a Scottish novelist, essayist, and poet who became one of the world's most popular writers. His exciting adventure stories *Treasure Island* and *Kidnapped* have long appealed to both children and adults. His essays and travel books are considered models of sophisticated English prose style, while the tender, simple poems collected in *A Child's Garden of Verses* are masterpieces of children's literature.

Stevenson's life was as varied and fascinating as his work. He fought illness constantly, writing many of his best books from a sickbed. He traveled widely for his health and to learn about people. He spent his last years on the South Sea island of Samoa, and the Samoans honored him with the title *Tusitala* (Teller of Tales).

Stevenson's Life

Early Life. Stevenson was born on Nov. 13, 1850, in Edinburgh, Scotland. His full name was Robert Lewis Balfour Stevenson. He later adopted the name Robert Louis Stevenson. He was a sickly boy who suffered from a lung disease that later developed into tuberculosis. Young Stevenson loved the open air, the sea, and adventure, but he also loved to read. He preferred literature and history, especially Scottish history which supplied the background for many of his novels.

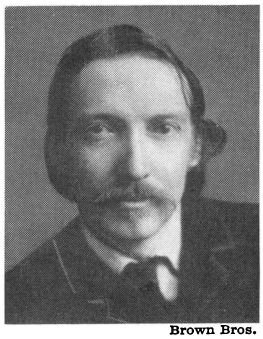
When he was 17, Stevenson entered Edinburgh University to study engineering, his father's profession. However, he soon gave up engineering for law. He passed his bar examination in 1875, but he did not enjoy law and never practiced it. His real love was writing.

Stevenson began publishing short stories and essays in the mid-1870's. His first book, *An Inland Voyage*, appeared in 1878. It relates his experiences during a canoeing trip through France and Belgium. In *Travels with a Donkey in the Cévennes* (1879), Stevenson describes a walking tour through part of France. Although both books reveal Stevenson's inexperience as a writer, they give signs of the graceful, charming essay style for which he was to become famous.

Marriage. In 1876, Stevenson met Mrs. Fanny Osbourne, a married American woman who was studying art in Paris. Although she was 11 years older than Stevenson and had a son and daughter, Stevenson fell in love with her. In 1879, he followed her to San Francisco in spite of the opposition of his parents. They were married in Oakland in 1880, after her divorce. The long journey from Europe to California severely affected Stevenson's frail health. To speed his recovery, he moved his family to a rough mining camp in the mountains near St. Helena, Calif. Stevenson described his experiences there in *The Silverado Squatters* (1883).

The Stevensons returned to Scotland in 1880. For the next seven years, they moved through Europe from one resort to another, hoping that a change of air would improve Stevenson's health. In 1887, Stevenson returned with his family to the United States, where he entered a sanitarium at Saranac Lake, N.Y.

The South Seas. For Stevenson, the sea had always been bracing. When his health improved, he boldly decided to sail a yacht to the South Seas. He left San Francisco with his wife, widowed mother, and stepson in June, 1888, and for the next six years traveled through



Brown Bros.

Robert Louis Stevenson settled with his family near Apia on Upolu, one of the Samoan islands in the South Seas. There he built a large house which he called *Vailima*. This picture shows Stevenson seated next to his wife Fanny. Stevenson's mother and stepson Lloyd Osbourne (standing) are shown on the author's right.

Stevenson House, Edinburgh

the South Sea islands. He came to know the life of the islanders better than any writer of his time.

Eventually, Stevenson decided to settle in the South Seas, the one place that seemed to promise some lasting improvement in his health. He bought some forest land near Apia, Samoa, and built a large house, which he called *Vailima* (Five Rivers). He became a planter and took an active part in island affairs. Stevenson's kindness, understanding, and tolerance gained the affection of the Samoans, who built a road to his house which they called *The Road of the Loving Heart*.

Tragedy clouded Stevenson's last years when his wife suffered a nervous breakdown. This misfortune moved him deeply, affecting his ability to complete his last books. Stevenson's life was beginning to brighten when his wife partially recovered, but he died suddenly of a stroke on Dec. 3, 1894. Local chiefs buried him on top of Mount Vaea, where his gravestone is inscribed with his own poem, "Requiem." Its concluding lines make a fitting epitaph for a gallant adventurer:

> Here he lies where he longed to be;
> Home is the sailor, home from the sea,
> And the hunter, home from the hill.

Stevenson's Writings

Novels. In 1881, Stevenson amused his stepson, Lloyd Osbourne, with a little tale about pirates and the buried treasure of Captain Kidd. It grew into *Treasure Island*, Stevenson's first and most famous novel. The story, first published in a boy's magazine, was revised for book publication in 1883. The boy hero Jim Hawkins, the two villains Long John Silver and blind Pew, and the hair-raising search for the buried treasure have become familiar to millions of readers.

With the publication of Stevenson's second major novel, *The Strange Case of Dr. Jekyll and Mr. Hyde* (1886), his reputation was assured. The story tells of a doctor who takes a drug that changes him into a new person, physically ugly and spiritually evil. As a psychological inquiry into the nature of the evil that exists in all men, the novel brilliantly anticipates much modern psychological fiction and is one of the most fascinating horror stories ever written.

Stevenson also published *Kidnapped*, his best long novel, in 1886. Based on considerable historical research, it weaves an exciting fictional story around an actual Scottish murder in 1745. The novel displays Stevenson's matchless ability to create adult entertainment out of the materials of children's adventure stories. Because of its length, Stevenson ended *Kidnapped* before the plot was completed. He finally finished the story in 1893 with a sequel, *David Balfour* (published in England as *Catriona*).

The Master of Ballantrae (1889) is set against the background of Scotland's revolt against England in the 1740's. The novel, which tells a story of bitter hatred between two brothers, begins as a promising psychological study, but suffers from its melodramatic ending.

Stevenson's later novels, far different from his early light-hearted romances, are often bitter in tone. Less popular, they still have merit. The short novel *The Beach of Falesá* (1892), which Stevenson described as "the first realistic South Sea story," was called "art brought to a perfection" by novelist Henry James.

Stevenson wrote three other novels, in collaboration with Lloyd Osbourne—*The Wrong Box* (1889), *The Wrecker* (1892), and *The Ebb Tide* (1894). Stevenson also left two novels unfinished at his death. *St. Ives*, which was completed by Sir Arthur Quiller-Couch, describes the adventures of a French prisoner in Britain in 1813. *Weir of Hermiston*, a story of Scotland in the 1700's, promised to be Stevenson's finest novel.

Other Writings. Stevenson wrote many short stories, some of which were collected into *New Arabian Nights* (1882) and *More New Arabian Nights* (1885). Many of

the stories are rich in imagination and fantasy, although the early ones are often written in an artificial style.

Stevenson's concern with prose style is most apparent in his essays, which are among the finest in the language. His observations on men and manners are marked by a delicate fancy. For charm and perceptiveness, they can be compared only to the essays of Charles Lamb and William Hazlitt. Stevenson's most memorable essays were collected in *Virginibus Puerisque and Other Papers* (1881), *Familiar Studies of Men and Books* (1882), and *Memories and Portraits* (1887).

Stevenson wrote several travel books later in his career. The *Amateur Emigrant* (1880, 1895) describes his voyages to the United States; *Across the Plains* (1892) tells of his trip from New York to San Francisco; *In the South Seas* (1890) contains his reflections on his Pacific voyages. All demonstrate Stevenson's extraordinary stylistic quality—the sudden word or phrase that lights a page with meaning.

Stevenson also composed some delightful letters, wrote several volumes of poetry, and collaborated with William Ernest Henley on some unsuccessful dramas. *A Child's Garden of Verses* (1885) reveals the world of a child's imagination with a deceptive simplicity that still appeals to readers young and old. His adult poetry, however, is almost totally ignored today, in spite of occasional pieces of considerable merit.

Stevenson's Place in Literature

Stevenson was both the most popular and the most successful among writers of the late 1800's who developed romance as a reaction to the literary movements of realism and naturalism. If his influence has declined today, it is not necessarily because modern writers are more skillful, but rather that Stevenson's optimistic view of life has become unfashionable.

Stevenson insisted that novels are to adults what play is to children, and that one of the legitimate and necessary functions of literature is to supply adventure for people who lead unexciting lives. A theory of fiction seemingly so limited and naïve might well have produced literary trifles. In fact, it resulted in art of such high quality that the disciplined Henry James once praised Stevenson as "the only man in England who can write a decent English sentence."

Stevenson's faults are obvious. His plots are a bit melodramatic, his pirates rather stagy, and, as he readily admitted, his heroines entirely unreal. But his sure handling of narrative pace, his strong sense of atmosphere, and above all his masterly command of style give his novels and stories enduring vitality. The reading public has never lost its admiration for Stevenson, and it appears likely that as long as there is a taste for romance written with artistry, he will continue to have an audience. Furthermore, there are signs that critics are re-evaluating his works, finding more fine shades of meaning in his writings than they had suspected.

Critically reviewed by FRANK W. WADSWORTH

See also *Stevenson, Robert Louis*, in the RESEARCH GUIDE/INDEX, Volume 22, for a *Reading and Study Guide*.

STEWARDESS. See FLIGHT ATTENDANT.

STEWART, MICHAEL (1906-), served as British secretary of state for foreign and Commonwealth affairs from 1968 to 1970. Prime Minister Harold Wilson had named Stewart to the Cabinet in 1964.

Stewart was born in London and graduated from Oxford University. He taught school for 12 years, and then joined the Army Intelligence Corps in 1942. Stewart was elected to Parliament in 1945, and was undersecretary of war from 1947 to 1951. In 1951, he served as parliamentary secretary to the minister of supply until the Labour Party lost the election held five months after his appointment. In 1964, when the party returned to power, Stewart was named secretary of state for education and science. He served as secretary of state for foreign affairs from 1965 to 1966 and for seven months in 1968. He also was first secretary of state from 1966 to 1968.

STEWART, POTTER (1915-), was appointed an associate justice of the Supreme Court of the United States in 1958. He became the second youngest justice in 105 years. Stewart was born in Jackson, Mich. His father, James Garfield Stewart, became an Ohio supreme court judge. Potter Stewart attended Yale University, Yale University Law School, and Cambridge University. He practiced law in Cincinnati, and was elected to the Cincinnati city council in 1949. He served as a judge of the federal court of appeals from 1954 to 1958. See also SUPREME COURT OF THE UNITED STATES (picture). MERLO J. PUSEY

STEWART ISLAND. See NEW ZEALAND (Other Islands).

STEWING. See COOKING (Boiling and Simmering).

STIBNITE. See ANTIMONY; MINERAL (color picture).

STICK, a term used in printing. See TYPE (How Type Is Set; pictures).

STICK-BUTTON. See BURDOCK.

STICK INSECT. See WALKING STICK.

STICKLEBACK, *STIK'l BAK*, is a name given to a family of small fishes of the Northern Hemisphere. They are called sticklebacks because some of their fins are made of strong, sharp, separated spines. Instead of having scales, the body is usually covered by hard plates. There are both fresh-water and ocean sticklebacks. The fresh-water ones reach a length of 1 to 3 inches (2.5 to 7.6 centimeters). The ocean sticklebacks grow to be not more than 7 inches (18 centimeters) long. The *brook stickleback* is common in the interior parts of Canada and in the Great Lakes states. These fish, like other sticklebacks, build muff-shaped nests of sticks and roots for receiving the spawn. The male carefully guards the spawn. He also watches over the young for several days after the eggs are hatched. Sticklebacks eat the young of other fish. See also INSTINCT.

Scientific Classification. Sticklebacks make up the stickleback family, *Gasterosteidae*. The three-spined, or *common*, stickleback is classified as genus *Gasterosteus*, species *G. aculeatus*. The brook stickleback is classified as genus *Eucalia*, species *E. inconstans*. CARL L. HUBBS

STICKSEED is a weedy plant that grows wild in dry soils throughout most of North America. It is named stickseed because its small, nutlike fruit has barbed prickles that stick to clothing and to the fur or hair of animals. Stickseed has a slender hairy stem, grayish-green leaves, and small blue, lavender or white flowers.

Scientific Classification. Stickseed is in the borage family, *Boraginaceae*. Annual species are genus *Lappula*. Perennials and biennials are genus *Hackelia*. ARTHUR CRONQUIST

STIEGEL, *STEE gel,* **HENRY WILLIAM** (1729-1785), was an early American iron and glass manufacturer. Among his iron products were tin-plate wood stoves that were used widely for many years, and iron castings used by sugar planters and refiners in the West Indies.

In 1762 Stiegel and two associates established the town of Manheim, Pa. There he conducted experiments in glassmaking and soon produced his "Stiegel glass." Some experts regard "Stiegel glass" as the most beautiful glass ever blown, and collectors prize it highly (see GLASSWARE [Stiegel Glass]).

Stiegel was born near Cologne, Germany, and came to Philadelphia in 1750. He had a substantial fortune when he arrived, and he became a prominent landowner and ironmaker. He lived in great style and assumed the title of baron. His extravagant personal spending, coupled with disturbed economic conditions in the American colonies, brought financial disaster. He was imprisoned for debt in 1774. JOHN B. MCFERRIN

See also ANTIQUE (picture: Glass Saltcellar); COLONIAL LIFE IN AMERICA (color picture: Stiegel Glass).

STIEGLITZ, *STEEG lits,* **ALFRED** (1864-1946), pioneered in photography as a creative art. His photographs are among the greatest ever produced. In 1902, he founded, with Edward Steichen, the Photo-Secession, an organization to promote photography as an art form. From 1905 until 1946, he operated a gallery in New York City, where he showed paintings as well as photographs. Stieglitz was the first in the United States to exhibit French postimpressionist paintings. He was born in Hoboken, N.J., and studied at the City College of New York. In 1924, Stieglitz married Georgia O'Keeffe, the painter. BEAUMONT NEWHALL

See also PHOTOGRAPHY (History [Photography for Everyone; picture]); O'KEEFFE, GEORGIA.

STIGMA, in botany. See FLOWER (The Pistils; color diagram: Parts of a Flower); POLLEN AND POLLINATION.

STIKINE RIVER, *stih KEEN,* is an important waterway in northern British Columbia. It rises in the Cassiar Mountains and flows westward and southward for about 335 miles (539 kilometers). The Stikine River empties into the Pacific Ocean near Wrangell, Alaska. It drains an area of about 20,000 square miles (52,000 square kilometers). JOHN BRIAN BIRD

STILETTO. See DAGGER.

STILL. See DISTILLATION.

STILL, ANDREW TAYLOR. See OSTEOPATHY (History).

STILLWATER, Minn. (pop. 10,191), is 18 miles (29 kilometers) northeast of St. Paul. It was one of the earliest settlements in the state. It was established in 1839. For many years Stillwater served as an important logging center for lumbering in the nearby pine forests. The city lies on the boundary between Minnesota and Wisconsin near the mouth of the St. Croix River, at a point where the river widens into a lake (see MINNESOTA [map]). Stillwater is called the *Birthplace of Minnesota.* The convention that formed the territory of Minnesota met there in 1848. The city has a mayor-council form of government. HAROLD T. HAGG

STILT is a wading bird with long, slender legs. These slender legs make it look as if it walks on stilts. The stilts are related to the avocets, and live in both the Eastern and Western hemispheres. The *black-necked stilt,* the only American stilt, is about 15 inches (38 centimeters) long. The upper part of its body is black, and the under part is white. Its long legs are bright red. The stilt builds its nest by lining a low place in the ground with grasses. The female stilt lays 3 or 4 eggs of an olive or buff color, thickly spotted with chocolate tones. The bird lives along shallow ponds in fresh and salt marshes. See also AVOCET.

S. A. Grimes

The Stilt Is a Wading Bird with Long, Slender Legs.

Scientific Classification. The stilt belongs to the stilt and avocet family, *Recurvirostridae.* The black-necked stilt is genus *Himantopus,* species *H. mexicanus.* ALFRED M. BAILEY

STILTS are two long poles that allow a person to walk with his feet some distance above the ground. Each stilt has a footrest fastened to it. A stilt walker stands on the footrests, keeps the top of the stilts in his armpits, and grips the stilts with his hands. With each step he moves a stilt forward with his hands. Some stilt walkers strap their legs to the stilts so they can use the motion of their legs to operate the stilts.

Stilts are used chiefly for amusement. Children like to walk on them. Some circus performers entertain by walking on stilts.

No one knows when stilt walking began. Hundreds of years ago, people in some areas used stilts to walk above water during floods. A legend dating from the 1600's tells of soldiers using stilts in Namur, Belgium. Some farmers in parts of Gascony, France, once used stilts to wade in marshland and cross streams. They could run on stilts with remarkable speed and ease.

STILWELL, JOSEPH WARREN (1883-1946), commanded all the United States forces in the China-Burma-India theater of war during World War II. He also served as chief of staff to Generalissimo Chiang Kai-shek, supreme commander of the Chinese theater, and was the first American general to command a Chinese army. Stilwell won the nickname of *Vinegar Joe* because of his forthright manner.

Stilwell was sent to Burma in 1942 to assist the Chinese and British troops defending Burma against Japan. When the Allied forces were defeated in Burma, Stilwell retreated to India, a distance of about 140 miles (225

kilometers) through the jungle. In India, he trained several Chinese divisions to recapture Burma and open a line of communication to China. With these forces and a small American force called "Merrill's Marauders," Stilwell opened a route to China late in 1944. Stilwell and Chiang Kai-shek disagreed on military policy, and Stilwell was shifted to Washington, D.C., in October, 1944. In June, 1945, Stilwell took command of the U.S. Tenth Army on Okinawa. After the war ended, he held an Army command in the United States.

Stilwell was born in Palatka, Fla. He was graduated from the United States Military Academy in 1904. He served with the American Expeditionary Forces in France during World War I. He studied Chinese, and served as a military attaché in China from 1935 to 1939. MAURICE MATLOFF

See also MERRILL'S MARAUDERS.

STILWELL ROAD. See WORLD WAR II (The China-Burma-India Theater).

STIMSON, HENRY LEWIS (1867-1950), was an American statesman. As secretary of state under President Herbert Hoover, he opposed Japan's seizure of Manchuria in 1931 by a warning known as "The Stimson Doctrine." This stated that the United States would not recognize any changes made there in violation of treaties. Hoover refused to permit him to use an economic boycott against Japan. But, in 1940, as secretary of war under President Franklin D. Roosevelt, Stimson successfully urged such a boycott. Japan refused to yield to any pressure and struck Pearl Harbor, opening war against the United States. Stimson served as secretary of war from 1940 to 1945 under Presidents Franklin D. Roosevelt and Harry S. Truman.

He was President William Taft's secretary of war from 1911 to 1913 and promoted "dollar diplomacy" to aid defense. Stimson acted as President Calvin Coolidge's mediator in Nicaragua in 1927. He was born in New York City. HARVEY WISH

STIMULANT is a drug that causes an increase in the activity of an organ of the body. The term usually refers to chemicals that excite or increase certain activities of the brain. Some stimulants, such as the amphetamines and caffeine, make a drowsy person more wakeful. They do so by stimulating the central nervous system (see NERVOUS SYSTEM [The Central Nervous System]). A period of depression may follow the stimulation that results from taking an amphetamine.

The body may react to a particular stimulant in different ways, depending on the dosage. For example, a small dose of strychnine, a poison, stimulates the central nervous system. But an overdose of strychnine may cause severe disturbance, convulsions, and death.

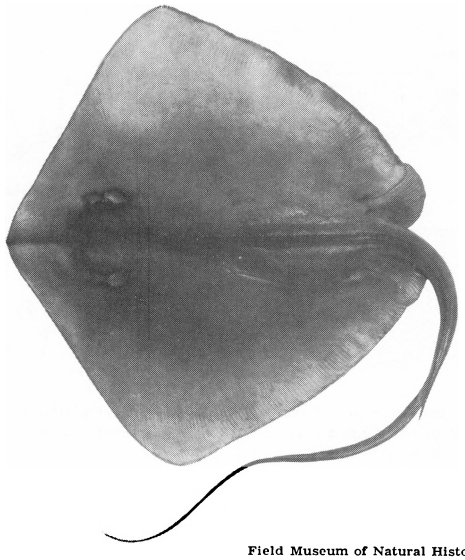
Coffee, tea, and some cola drinks contain caffeine. Tobacco contains a stimulant, nicotine. EDWARD F. DOMINO

See also ADRENALIN; AMPHETAMINE; CAFFEINE; DRUG ABUSE; NICOTINE.

STIMULUS. See REFLEX ACTION; PSYCHOLOGY (Behaviorism); LEARNING (How We Learn).

STING. See ANT (Abdomen); BEE (Sting); MOSQUITO; SCORPION; WASP.

STING RAY, also called STINGAREE, is a ray, or flattish sea fish. Its long, flexible tail has one or two sharp spines on the back of the tail near the middle. These spines have teeth along their edges. At the base of these teeth are poisonous glands. When bathers disturb or step on the sting ray, it swings its tail upward. In this way, it causes a most painful wound that is nearly as dangerous as a poisonous snakebite. The fish live on sandy to muddy bottoms in all warm shallow parts of the ocean and in bays. In South America, small, freshwater sting rays infest the rivers flowing into the Atlantic Ocean. These sting rays live as far as 2,000 miles (3,200 kilometers) above the mouth of the Amazon River. A sting ray that lives in the waters off Australia reaches a length of 14 feet (4 meters).

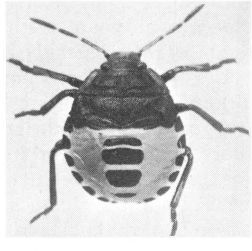


Field Museum of Natural History

The Flat-Bodied Sting Ray, *above,* **can inflict a serious wound with the strong, sharp spine on its whiplike tail.**

Scientific Classification. Sting rays belong to the sting ray family, *Dasyatidae.* There are about 50 species of sting ray. The common sting ray is classified as genus *Dasyatis,* species *D. centrourus.* LEONARD P. SCHULTZ

STINKBUG is one of a family of insects that can spray bad-smelling odors. They have scent glands near their hind legs or on their abdomens. When stinkbugs are frightened, they open the glands and spray out a bad odor. Many stinkbugs are brown or green, but some are brilliantly colored. The red and black *harlequin bug* damages cabbage.



USDA

Southern Green Stinkbug

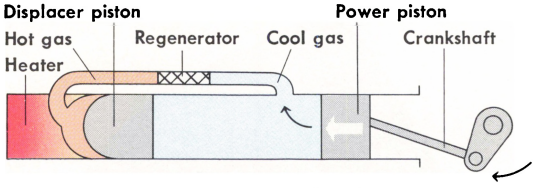
Scientific Classification. Stinkbugs belong to the order *Hemiptera.* They are members of the stinkbug family, *Pentatomidae.* The harlequin bug is classified as genus *Murgantia,* species *M. histrionica.* LEWIS J. STANNARD, JR.

STINKHORN. See MUSHROOM (Poisonous Mushrooms).

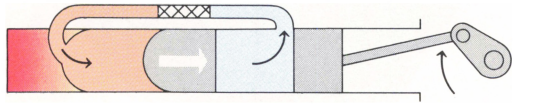
STIPULE. See LEAF (The Stipules).

STIRLING ENGINE is an experimental source of power that someday may be widely used in automobiles, boats, and other vehicles. Stirling engines run

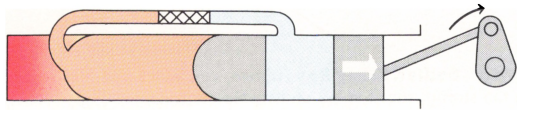
How a Stirling Engine Works



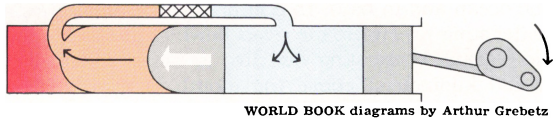
A cycle of a Stirling engine begins when the power piston moves toward the displacer piston. This action causes the cool gas between the two pistons to start flowing up to the regenerator.



The displacer piston moves toward the power piston, forcing the cool gas through the regenerator to be heated. The heated gas then flows into the space behind the displacer piston.



The heater outside the cylinder supplies additional heat to make the gas expand. The expanding gas causes both the displacer piston and the power piston to move in a power stroke.



WORLD BOOK diagrams by Arthur Grebetz

The displacer piston returns to its original position, forcing the gas to flow back through the regenerator, which absorbs its heat. The cooled gas then re-enters the space between the pistons.

more efficiently and produce less air pollution than do most other kinds of engines.

A typical Stirling engine has a sealed cylinder that contains a gas—either helium or hydrogen. The gas goes through a cycle of pressure changes by means of a process of alternate heating and cooling. A device called the *regenerator* partially heats the gas at the beginning of the cycle. A heater outside the cylinder provides additional heat by burning a fuel, such as diesel oil, kerosene, or alcohol. At the end of the cycle, the regenerator cools the gas by absorbing its heat.

The gas expands and contracts as it goes through the cycle of pressure changes. In doing so, it causes a power piston to move back and forth inside the cylinder. A rod connects the power piston to a crankshaft that converts the piston's *reciprocating* (back-and-forth) motion to the rotary motion of the drive shaft. This action, in turn, causes a *displacer piston* to move back and forth and force the gas through the regenerator.

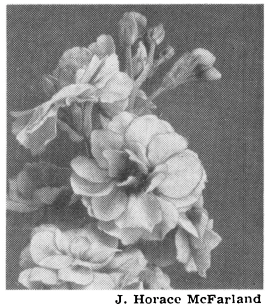
Robert Stirling, a Scottish minister, invented the Stirling engine in 1816. Stirling engines have never come into general use because they cost more to build than other types. During the 1960's and 1970's, scientists sought better engines, especially for cars, and conducted research on Stirling engines. PHILLIP S. MYERS

STIRRUP. See EAR (The Middle Ear; pictures).

STITCH. See SEWING (Basic Stitches).

STOAT. See ERMINE.

STOCK is a name given to three different garden flowers. The *Grecian stock* bears fragrant lilac or purple flowers which open at evening. This small, branching annual plant comes from southern Europe. Its pods have two noticeable horns on the end. The *Virginian stock* is another annual with small white, red, or lilac-colored flowers. It has a short stalk and pods with no horns. The *Brampton*, or *common*, *stock* is about 2 feet (61 centimeters) high. It bears fragrant white, pink, red, purple, or yellow blossoms.



J. Horace McFarland

Stock Blossoms

Scientific Classification. The stocks belong to the mustard family, *Cruciferae*. Grecian stock is genus *Matthiola*, species *M. bicornis*. Brampton stock is *M. incana*. Virginian stock is *Malcolmia maritima*. DONALD WYMAN

STOCK, CAPITAL, is a right of ownership in a corporation. The stock is divided into a certain number of *shares*, and the corporation issues each stockholder one or more *stock certificates* to show how many shares he holds. The stockholders own the company and elect a board of directors to manage it for them.

The Stockholder may sell his stock whenever he wants to unless the corporation has some special rule to prevent it. Prices of stock change according to general business conditions and the earnings and future prospects of the company. If the business is doing well, the stockholder may be able to sell his stock for a profit. If it is not, he may have to take a loss.

Large corporations may have many thousands of stockholders. Their stock is bought and sold in market places called *stock exchanges*. When a sale is made, the seller signs the certificate. The buyer turns this over to the corporation and gets a new certificate.

When the corporation has made a profit, the directors may divide the profit among the stockholders as *dividends*, or they may decide to use it to expand the business. Dividends may be paid only out of the corporation's profits. When profits are used to expand the business, the directors and stockholders may decide to issue more stock to show that there is more money invested in the business. This new stock will be divided among the stockholders as a *stock dividend*.

Kinds of Stock. The Articles of Incorporation—papers signed when the corporation is formed—may specify the different kinds of stock. *Par stock* must be issued for not less than a set price, called the *par value*, for each share. If the articles provide for *no-par* stock, the directors determine the issuing price of the stock and may change it whenever they wish.

All shares of stock have equal dividend and voting rights unless the articles provide differently. There may be different classes of stock, such as *voting* and *nonvoting*. Many articles provide for *common* and *preferred* stock. Preferred stock is entitled to a preference on dividends. That is, the directors must pay a certain

New York Stock Exchange

The New York Stock Exchange on Wall Street is often called the *nation's market place.*

amount—usually a percentage of par value—to the holders of preferred stock before they pay anything to the holders of common stock. If the preferred-stock holders share with the common-stock holders in dividends beyond the specified percentage, the stock is called *participating preferred.*

Preferred stock may also be *cumulative.* That is, if there are no dividends given in a year, the preferred-stock holders must be given double their dividend the next year. This double dividend is paid before anything is paid to the common-stock holders. It will continue to multiply for as many years as dividends are not paid.

When a corporation goes out of business, it divides its property among the stockholders. This process is called *liquidation.* When a company liquidates, the preferred-stock holders may be given the par value of their stock before the common-stock holders are given anything. This preferred stock is said to be *preferred up to par on liquidation.* ROBERT E. RODES, JR.

See also the articles INVESTMENT and STOCK EXCHANGE, with their lists of Related Articles.

STOCK, FREDERICK AUGUST (1872-1942), conducted the Chicago Symphony Orchestra from 1905 to 1942. Stock joined the orchestra in 1895. In 1899, he became assistant to Theodore Thomas, the director. He became director after Thomas died. Stock was born at Jülich, near Aachen, Germany. He graduated from the Cologne Conservatory. DAVID EWEN

STOCK CAR. See AUTOMOBILE RACING.

STOCK EXCHANGE is a market place where member *brokers* (agents) buy and sell stocks and bonds of American and foreign businesses on behalf of the public. A stock exchange provides a market place for stocks and bonds in the same way a board of trade does for commodities. The stockbrokers receive a small commission on each transaction they make.

How a Stock Exchange Operates

Federal and state laws regulate the issuance, listing, and trading of most securities. The Securities and Exchange Commission (SEC) administers the federal laws.

Listing Stocks. Stocks handled by one or more stock exchanges are called *listed stocks.* A company that wants to have its stock listed for trading on an exchange must first satisfy the exchange that it has enough paid-up capital, is a lawful enterprise, and is in good financial condition. Specific listing requirements vary among exchanges. On the New York Stock Exchange a corporation must have 2,000 stockholders who together hold at least 1 million shares, as well as a yearly earning power under competitive conditions of over $\$2\frac{1}{2}$ million before taxes. Major exchanges suspend trading in certain stocks which no longer meet minimum requirements.

Unlisted securities are sold in *over-the-counter* trading. Most bonds are sold this way. Many unlisted industrial securities are more speculative than listed ones. They are usually not traded on any exchange.

All stocks *fluctuate* (change) in value. Unforeseen circumstances may have lessened the earning power of a company and thus lowered the price that people are willing to pay for shares. Prosperous times or better management may increase values.

Trading. A person who wishes to buy stock places an order with his brokerage house. The broker gets a *quotation* (price) by telephone or telegraph, and relays the order to the firm's partner on the floor of the exchange. He negotiates the sale, and then notifies the brokerage house. Such a transaction may take only a few minutes. It is recorded on tape, and sent by *stock ticker* to brokerage firms over a nationwide network.

Each year, investors trade billions of shares worth hundreds of billions of dollars. In the early 1970's, about 2,000 stocks were listed on the New York Stock Exchange. Stock prices often reflect the state of the economy. If business conditions are good, stock prices tend to rise, creating a *bull market.* If conditions are poor, stock prices drop, causing a *bear market.*

Memberships in exchanges are worth substantial sums of money because only a limited number are available. Each new member must meet a number of requirements and be formally recommended and approved by the

exchange's Board of Governors before he can buy a *seat* (membership) and operate on the stock exchange. Seat owners generally hold their places personally. The majority of them are partners or voting stockholders in brokerage firms or corporations which are known as *member organizations*. Many firms have more than one member on the Exchange.

Some exchange members, called *specialists*, concentrate on a limited group of securities assigned by the exchange. They also act as agents for other brokers. Others are *odd-lot dealers*, who transact amounts less than the regular trading unit, such as 1 to 99 shares for 100-share units. *Floor brokers*, or "$2 brokers," are unaffiliated with exchange firms, and assist *commission house* (member firm) brokers with their firm orders.

The value of memberships depends largely on current business conditions, the volume of transactions, and the market level of securities. The New York Stock Exchange has 1,366 members and 558 member organizations with about 3,780 offices throughout the nation. The price on this exchange has varied from $17,000 in 1942, during a business recession, to a high of $625,000 in 1929. Memberships on other exchanges may be worth from $1,500 to more than $275,000.

History

The first European stock exchange was established in Antwerp, Belgium, in 1531. There were no stock exchanges in England until the 1700's. A man wishing to buy or sell shares of stock had to find a broker to transact his business for him. In London, he usually went to a coffeehouse, because brokers often gathered there. In 1773, the brokers of London formed a stock exchange.

In New York City, brokers met under an old buttonwood tree on Wall Street. They organized the New York Stock Exchange in 1792. The American Stock Exchange, second largest in the United States, was formerly called the Curb Exchange because of its origin on the streets of New York City. Other major exchanges operate in Baltimore, Boston, Chicago, Cincinnati, Detroit, Honolulu, Los Angeles, Philadelphia, Pittsburgh, Salt Lake City, San Francisco, and Washington, D.C. Abroad, major stock exchanges are located in Amsterdam, The Netherlands; Brussels, Belgium; Buenos Aires, Argentina; Johannesburg, South Africa; London; Melbourne and Sydney, Australia; Mexico City, Mexico; Milan, Italy; Paris; Rio de Janeiro; Tokyo; and Montreal and Toronto, Canada. G. KEITH FUNSTON

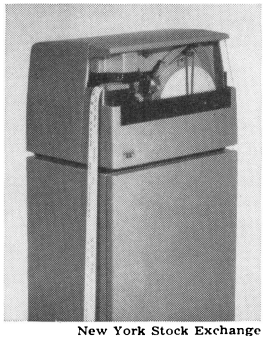
Related Articles in WORLD BOOK include:

Bears and Bulls	Bucket Shop	Securities and Exchange Commission
Blue-Sky Laws	Dow Jones Averages	Stock, Capital
Board of Trade	Investment Banking	Stock Ticker
Bond	Margin	
Bourse		

STOCK-MARKET CRASH. See UNITED STATES, HISTORY OF (The Great Depression).

STOCK RAISING. See LIVESTOCK.

STOCK TICKER is a teletype machine that prints a record of the purchase and sale of stock. The machine prints up to 900 characters or figures per minute on a tape that is 1-inch (2.5-centimeters) wide. The tape is often called *ticker tape*. About 3,800 tickers are in use in the United States. The New York Stock Exchange owns and maintains about 1,000 in the New York financial district. The Western Union Telegraph Company owns and maintains the others.



New York Stock Exchange

A Stock Ticker

The ticker works through a computer. A stockbroker telephones or teletypes an order to the trading floor of the Exchange. A broker representing the firm buys or sells the stock. An Exchange employee records the transaction on a special IBM card. This card contains the stock symbol listing the corporate title of the security, the number of shares involved, and the price. The card is placed in a *card reader* device located at each trading post on the Exchange floor. The device transmits the trading data into a computer complex. The computer converts the data into telegraphic signals that go over the Exchange's nationwide stock network. The report of a transaction appears on tickers a few seconds after the data have been fed into the computer.

The Stock Exchange first used tickers in 1867. Before that time, information was carried by mail or by messenger. G. KEITH FUNSTON

See also STOCK EXCHANGE; TELEGRAPH; EDISON, THOMAS ALVA (Early Inventions).

STOCKADE. See PIONEER LIFE IN AMERICA (Indian Attacks).

STOCKHAUSEN, *SHTOHK how zehn*, **KARLHEINZ** (1928-), a German composer, has been a leading force in the development of modern music since the early 1950's. Stockhausen creates music from unusual sounds. His compositions use synthetic electronic sounds and such natural noises as finger snapping, foot scraping, radio static, speech, and street sounds. He sometimes distorts these everyday sounds electronically.

Stockhausen has also experimented with *chance music*, in which the performer determines the order in which the sections of a composition are played. He has scattered the performers throughout a concert hall to produce a live stereo effect called *music in space*.

Experimental works by Stockhausen include *Kontakte* (1960), for electronic sounds, piano, and percussion; and *Spiral* (1968), for a soloist using a short-wave radio receiver. Stockhausen was born in Mödrath, Germany, near Cologne. JOSEPH BLOCH

See also ELECTRONIC MUSIC.

STOCKHOLDER. See STOCK, CAPITAL.

STOCKHOLM, *STAHK home* (pop. 723,688; met. area pop. 1,352,359), is the capital and largest city of Sweden. It is called the *Venice of the North* because of its many waterways.

Location and Description. Stockholm lies on Sweden's east coast, at the point where Lake Mälaren meets the Baltic Sea. The city is built on a dozen islands and along the shores of Lake Mälaren (see SWEDEN [political map]). Nearby are more than a thousand small islands that lie in Saltsjön Bay. Wide beaches on many of the islands are popular with sunbathers and swimmers during the summer. Ice hockey and skiing are popular winter sports. The cleanliness of its streets and build-

ings, the magnificence of its old palaces and churches, and the sharp clean lines of its office buildings make the city an expression of Swedish character.

Stockholm has a stadium which was the site of the 1912 summer Olympic Games. The city has athletic fields, children's playgrounds, clubs for most kinds of sports, and parks for walking and horseback riding.

The vast Djurgården park has been a pleasure resort of the people of Stockholm since the 1600's. The park contains a zoo and a large open-air museum. The buildings of the museum represent different provinces and historical periods of Sweden. They include an old pharmacy from the royal palace in Drottningholm, a combmaker's workshop, and a glassmaker's house.

The Town Hall, completed in 1923, with its three golden crowns, is one of the finest buildings in Sweden. The Riddarholm Church was founded in the 1200's and has been the burial place of Sweden's rulers since the 1500's. Storkyrkan, Stockholm's oldest church, was also founded in the 1200's. The greatest treasure of Storkyrkan is its statue of Saint George and the Dragon. Sten Sture commissioned it to commemorate a victory over the Danes in 1471. On a nearby island stand the *Riksdagshuset* (parliament building), and the *Riksbank*, the world's oldest government-owned bank.

Industry and Commerce. Stockholm is Sweden's most important industrial center. The three chief manufactured products, in order of their importance, are metal goods, paper, and foods. Many kinds of consumers' goods also are manufactured in the city. Stockholm is Sweden's second largest port, and large ocean-going ships tie up at its docks. The Göta Canal connects Stockholm with Göteborg on the west coast, and provides pleasure-boat trips through southern Sweden.

History. Birger Jarl, one of Sweden's greatest statesmen, is believed to have founded Stockholm in the early 1250's. From the 1200's to the 1500's, the Swedes fought many battles with the Danes in Stockholm in winning independence from the Danish rulers.

Lennart Olson, Pix

Vällingby Shopping Center, near Stockholm, is typical of new developments in the city's suburban areas.

King Christian II of Denmark and Sweden had the chiefs of the rebelling Swedish nobility beheaded in the so-called "Stockholm Blood Bath of 1520." The city became Sweden's capital in the 1600's. Stockholm celebrated its 700th anniversary in 1953. JAMES J. ROBBINS

See also SWEDEN (color pictures).

STOCKINGS are articles of clothing that fit snugly over the feet and part or all of the legs. Two forms of stockings, panty hose and tights, cover the feet and legs and reach to the waist. People wear stockings chiefly for comfort, warmth, and decoration and to protect their shoes from perspiration and foot odor.

How Stockings Are Made. Most panty hose and women's stockings are *sheer* (transparent). Most tights, men's hose, and children's stockings and some women's stockings are *opaque* (nontransparent). Nearly all sheer stockings are made of some kind of nylon yarn. Manufacturers make almost all opaque stockings from cotton, wool, or man-made fibers, such as nylon, olefin, and acrylic and polyester fibers. Such special stockings as support and surgical hosiery are made of rubber, spandex, and other highly elastic materials.

Stocking companies use two basic methods to make hosiery. Most seamless stockings are made on a *circular machine* that knits each stocking into a tubelike shape. The toe is then closed by hand or machine. Stockings with a seam, called *full-fashioned* hose, are made on a *flat-bed machine*. This machine knits a flat piece of fabric, varying the stitches to shape the leg and foot. Another machine sews the edges of the material together to form a seam down the leg and across the foot.

History. As early as the 400's B.C., people in ancient Greece and some other lands occasionally wore socklike foot coverings for warmth. The stockings were made of fabric and worn inside shoes. During the A.D. 400's, clergymen in western Europe began to wear long, tight stockings as a symbol of purity. By the 1000's, noblemen had also adopted this style of stocking.

Most stockings were made of woven cloth until the 1500's, when wealthy people began to wear hosiery produced by professional hand-knitters. In 1589, William Lee, an English minister, invented a machine that knitted full-fashioned stockings. By the late 1600's, many people wore machine-knitted hose. Manufacturers made most stockings of cotton, silk, or wool until the development of nylon in 1938. JANE SADDLER

See also CLOTHING (Clothing Through the Ages).

STOCKS. See STOCK, CAPITAL; STOCK EXCHANGE; INVESTMENT.

STOCKS are an old device used for punishment. Stocks are a wooden framework with holes for the legs of the victim, and sometimes also for the arms. Persons were placed in the stocks for minor offenses, such as drunkenness, for periods of a few hours to several days. Stocks were commonly used for punishment in American colonial days. In the North, women charged with being "common scolds" were sometimes punished in the stocks. In the South, disobedient slaves were placed in the stocks. Stocks were used until the early 1800's. See also PILLORY (with picture). MARVIN E. WOLFGANG

STOCKTON, Calif. (pop. 109,963; met. area 291,073), is an inland seaport. It lies 78 miles (126 kilometers) east of the Golden Gate of San Francisco Bay (see

CALIFORNIA [political map]). It was named by its founder, Captain Charles M. Weber, in honor of Commodore Robert Stockton of the U.S. Navy. The channel connecting San Francisco and Stockton is deep enough to accommodate the largest vessels of the American Merchant Marine. Shipments from the port include farm products of the surrounding valley, paper, cedar lumber, and farm machinery. Stockton was chartered as a city in 1850. It is the home of the University of the Pacific, founded in 1851. The city has a council-manager form of government. GEORGE SHAFTEL

STOCKTON, FRANK RICHARD (1834-1902), an American author, wrote humorous, fanciful tales. He first became known for his short fairy stories for children. Stockton's first collection of fairy tales, *Ting-a-Ling*, appeared in 1870. Some of his stories were published in the *St. Nicholas* magazine, which he helped edit from 1873 to 1881. His other collections of stories include *The Floating Prince and Other Fairy Tales* (1881) and *The Bee Man of Orn and Other Fanciful Tales* (1887).

Stockton published his first book for adults, *Rudder Grange*, in 1879. It is a novel of the fantastic adventures of a young couple living in a houseboat. He established his reputation when his best-known short story, "The Lady, or the Tiger?" appeared in 1882. This story, which is famous for its unusual ending, has been translated into many languages. It was followed in 1886 by *The Casting Away of Mrs. Lecks and Mrs. Aleshine.* Stockton was born in Philadelphia. JEAN THOMSON

STOCKTON, RICHARD (1730-1781), was a New Jersey signer of the Declaration of Independence. He served in the Continental Congress in 1776 and, in the same year, became chief justice of the New Jersey Supreme Court. He was responsible for securing John Witherspoon to serve as president of the College of New Jersey (see WITHERSPOON, JOHN). Stockton was born in Princeton. New Jersey has placed a statue of him in Statuary Hall in Washington, D.C. CLARENCE L. VER STEEG

STOCKYARDS. See MEAT PACKING (The Marketing of Livestock).

STODDARD, WILLIAM OSBORN (1835-1925), was an American author, journalist, and inventor. He was among the first to write that Abraham Lincoln should be elected President of the United States. He served as one of Lincoln's private secretaries from 1861 to 1864. He was United States marshal in Arkansas from 1864 to 1866. Stoddard patented nine inventions and wrote 76 books, including five on Lincoln, 10 on other United States Presidents, and many novels for boys. He was born in Homer, N.Y. WILLIAM H. GILMAN

STODDERT, BENJAMIN (1751-1813), America's first secretary of the navy, built the Navy up to some 50 vessels and 6,000 seamen. He pushed the purchase of navy yard sites and began basic construction of shore facilities at Portsmouth, N.H.; Charlestown, Mass.; Brooklyn, N.Y.; Philadelphia, Pa.; and Gosport, Va. He served from 1798 to 1801. Stoddert, born in Charles County, Maryland, was a merchant shipper. He served in the Revolutionary War. RICHARD S. WEST, JR.

STOIC PHILOSOPHY flourished from about 300 B.C. to A.D. 300. It began in Greece and then spread to Rome. The Stoic philosophers believed that each man has within himself reason, which relates him to all other men and to the Reason (God) that governs the universe. This belief provided a theoretical basis for *cosmopolitanism*—the idea that men are citizens of the world rather than of a single nation or area. This view also stimulated the belief in a natural law that stands above civil law and provides a standard by which men's laws may be judged. The Stoics felt that man achieves his greatest good—which is happiness—by following reason, freeing himself from passions, and concentrating only on things he can control.

The Stoic philosophers had their greatest influence on law, ethics, and political theory, but they also formulated important views on logic, the theory of knowledge, and natural philosophy. Zeno is considered the founder of Stoic philosophy. The early Stoics, particularly Chrysippus, were interested in logic and natural philosophy as well as ethics. The later Stoics, especially Seneca, Marcus Aurelius, and Epictetus, emphasized ethics. JOSIAH B. GOULD

See also ZENO; EPICTETUS; MARCUS AURELIUS; SENECA, LUCIUS ANNAEUS.

STOKE-ON-TRENT (pop. 262,120), the pottery center of England, lies on the Trent River about 35 miles (56 kilometers) south of Manchester (see GREAT BRITAIN [political map]). Josiah Wedgwood introduced fine chinaware in Stoke in the 1700's, and the potteries still form the main industry of Stoke-on-Trent. Wedgwood, Spode, and Staffordshire ware all come from this city. This district is the setting for Arnold Bennett's novels of the "Five Towns." FRANCIS H. HERRICK

STOKER. See HEATING (Coal).

STOKER, BRAM (1847-1912), a British author, wrote *Dracula* (1897), one of the most famous horror stories of all time. Count Dracula, the book's main character, is a nobleman who is really a *vampire* (blood-sucking killer). He lives in Transylvania (now part of Romania), and is several hundred years old. At night, he changes into a huge bat, and flies about the countryside drawing blood from the necks of sleeping victims. Dracula moves to England and terrorizes the people there. He is finally killed by a stake driven through his heart. *Dracula's Guest*, a continuation of *Dracula*, was not published until 1937. Stoker's other books include *The Mystery of the Sea* (1902), *The Jewel of Seven Stars* (1904), and *Famous Imposters* (1910).

Stoker was born in Dublin, Ireland. He was manager for actor Sir Henry Irving, and wrote *Personal Reminiscences of Henry Irving* (1906). JAMES DOUGLAS MERRITT

STOKES, CARL BURTON (1927-), served as mayor of Cleveland from 1967 to 1971. Stokes was the first elected Negro to head a major American city.

Stokes was born in Cleveland. His family was poor, and Stokes left high school at age 17 to go to work. He served in the Army from 1944 to 1946. After leaving the Army, he finished high school and worked his way through college. He graduated from the University of Minnesota and from Cleveland-Marshall Law School. He became a lawyer in 1957.

Stokes was elected to the Ohio House of Representatives in 1962. He was re-elected twice. In 1965, he ran for mayor of Cleveland as an independent, but lost. In 1967, he ran as a Democrat and defeated Republican Seth C. Taft, a grandson of President William Howard Taft. He was re-elected to a second two-year term in 1969. EDGAR ALLAN TOPPIN

STOKOWSKI, *stohKAWFskee,* **LEOPOLD** (1882-), is a famous orchestra conductor. During his long and influential career, he has extended the range of music played by symphony orchestras. He worked with engineers to improve the quality of recorded sound and sought new ways to bring music to larger audiences.

Houston Symphony Society

Leopold Stokowski

Stokowski was born in London. He was educated at Oxford University and at the Royal College of Music, where he learned to play several instruments. Stokowski moved to the United States in 1905 and became organist and choirmaster at St. Bartholomew's Church in New York City. In 1909, he became conductor of the Cincinnati Symphony Orchestra. From 1912 to 1938, he served as chief conductor of the Philadelphia Orchestra, sharing the last two seasons with Eugene Ormandy. After leaving the Philadelphia Orchestra, Stokowski appeared as guest conductor with orchestras in many countries. In 1962, he founded the American Symphony Orchestra of New York City. ROBERT C. MARSH

STOL. See CONVERTIPLANE; AIRPLANE (Aircraft of the Future).

STOLA. See TOGA.

STOMACH is an enlarged part of the alimentary canal. It lies between the *esophagus* and the small *intestine* (see ESOPHAGUS; INTESTINE). In man and most animals, it is a simple baglike organ. In cows, sheep, and other *ruminants* (animals that chew their cud), the stomach has four compartments and is more complicated than man's stomach (see RUMINANT).

Man's stomach is shaped much like a *J*. In most persons, it is located in the upper left side of the abdomen. But the position can vary. The upper end of the stomach connects with the esophagus. The lower end opens into the *duodenum*, the upper end of the small intestine. The stomach is a muscular organ. This allows it to churn and mix its contents and fit its shape to the amount of food it holds. The average adult stomach can hold a little more than 1 quart (0.9 liter), but the stomachs of individuals differ. Tall, thin persons usually have long, narrow stomachs. Short, stocky persons usually have short, wide stomachs.

The Stomach's Work. The stomach serves as a storage place for food, so that a large meal may be eaten at one time. It also helps digest food.

Glands in the stomach wall secrete mucus to lubricate the food. Other glands give off hydrochloric acid and the enzyme pepsin to partially digest the food. The hydrochloric acid kills any *microorganisms* (tiny living organisms such as bacteria) in the food.

The stomach muscles churn the food and digestive juices into a pulpy liquid. Then the muscles squeeze the liquid toward the *pyloric* (intestinal) end of the stomach by ringlike contractions of the muscles. These contractions, called *peristaltic waves*, occur about 20 seconds apart. They start at the top of the stomach and move downward. The *pylorus*, a ringlike muscle around the duodenal opening, keeps food in the stomach until it is a liquid. Then the pylorus relaxes and lets some *chyme* (liquid-digested food) pass into the duodenum.

The churning action of the stomach tends to begin at our usual mealtimes. When a person says his stomach is "growling," he is referring to these peristaltic waves. Sometimes, these movements grow so strong that they squeeze acid gastric juice up into the lower part of the esophagus. This irritates the tissues there and causes discomfort.

The pylorus allows water to pass through almost as soon as it enters the stomach. But the length of time that the stomach retains food varies. On the mixed diet that most persons eat, the stomach empties in three to five hours.

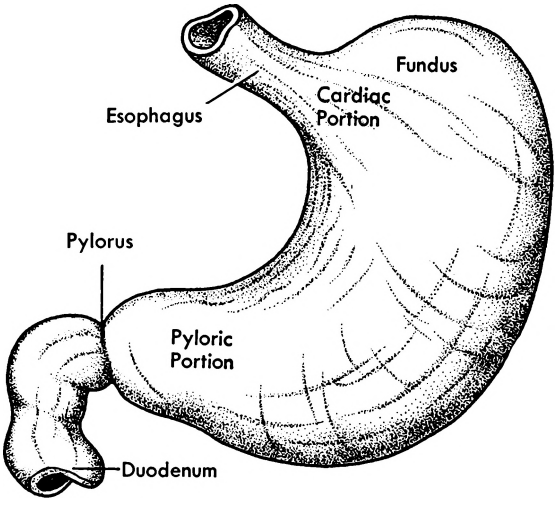
When food enters the stomach, it contains *ptyalin*, an enzyme in saliva that partially digests starch. This action is stopped immediately by the hydrochloric acid in the stomach. No further digestion of starch occurs until the chyme enters the small intestine. For this reason, salivary ptyalin is not very important to digestion.

The enzymes secreted in the stomach are *pepsin*, which partially digests proteins and clots milk; and *rennin*, which also clots milk. Rennin is probably important only in infants. Infants also have *gastric lipase*, an enzyme that digests fat in the stomach. In adults, fat digestion occurs in the small intestine.

Although the stomach performs several useful functions, it is not absolutely essential for life. Many persons lead long lives after their stomachs are either partially or wholly removed because of cancer or ulcers.

Stomach Diseases. Many foods irritate the mucous membrane that lines the stomach. Such foods include highly spiced foods, extremely hot foods, and some alcoholic drinks. Rough and dry food that is not well chewed can irritate the stomach. Fear, anger, or constant tension can cause an excessive secretion of stomach juices even when no food is present. This greatly irritates the stomach and the duodenum. If made worse by

THE STOMACH



hastily eaten coarse food, a person can develop ulcers in the stomach or duodenum. Duodenal ulcers almost always result from too much secretion in the stomach. Excessive smoking and drinking of beverages that contain alcohol or caffeine make a person more susceptible to ulcers. Ulcers often heal themselves if the patient eats a simple diet, usually containing milk, and avoids tension. In severe cases, doctors treat ulcers by surgery. TERENCE A. ROGERS

Related Articles. See the Trans-Vision three-dimensional color picture with HUMAN BODY. See also:

Alimentary Canal	Food	Nausea
Animal (How Animals Eat)	Gastritis	Ruminant
Digestion	Gastroscope	Ulcer
	Ileum	Vomiting

STOMACH-ACHE. See INDIGESTION.

STOMATA. See LEAF (The Leaf as a Food "Factory").

STONE. See BUILDING STONE; ROCK.

STONE is a unit of weight. See WEIGHTS AND MEASURES (Avoirdupois Weight).

STONE, EDWARD DURELL (1902-), is an American architect who gained fame for harmonizing buildings with their cultural surroundings. For example, Stone adapted elements of Indian architecture for his United States embassy building in New Delhi, India (see NEW DELHI [picture: The U.S. Embassy Building]). In this and other buildings, Stone made extensive use of grillwork. He also designed the U.S. pavilion at the 1958 Brussels Worlds Fair, the Museum of Modern Art in New York City, the North Carolina State Legislative Building in Raleigh, and the John F. Kennedy Center for the Performing Arts in Washington, D.C. His book *The Evolution of an Architect* was published in 1962. Stone was born in Fayetteville, Ark. He studied at the University of Arkansas and at Harvard and M.I.T. HUGH MORRISON

STONE, HARLAN FISKE (1872-1946), served as chief justice of the United States from 1941 until his death. The years he served as chief justice on the Supreme Court were marked by changing constitutional views and by division within the court. Stone became an associate justice in 1925. Although a conservative, Stone often joined Louis D. Brandeis and Oliver Wendell Holmes in upholding liberal, progressive measures.

Stone was born at Chesterfield, N.H., the son of a farmer. He was graduated from Amherst College in 1894, and then studied at the Columbia University Law School. From 1899 to 1905, he taught law at Columbia. For a time he practiced law in New York City, and became a noted corporation lawyer. Stone served as dean of the Columbia University Law School from 1910 to 1923. He became attorney general of the United States in 1924 and cleaned up scandals in the Department of Justice. MERLO J. PUSEY

Harlan F. Stone
Wide World

STONE, IRVING (1903-), is an American biographer and novelist. His first important work was *Lust for Life* (1934), a novel about Vincent van Gogh, the painter. He also wrote *The President's Lady* (1951), the life of President Andrew Jackson's wife; *Love Is Eternal* (1954), about Mary Todd Lincoln; and *The Agony and the Ecstasy* (1961), a story of Michelangelo's life. Stone was born in San Francisco. GEORGE J. BECKER

STONE, LUCY (1818-1893), was the first American woman to lecture on woman's rights, and probably the first married woman to keep her maiden name. She became a famous antislavery and woman-suffrage speaker, and converted Susan B. Anthony and Julia Ward Howe to her cause. She helped organize associations for woman's rights. Miss Stone was born in West Brookfield, Mass., and was graduated from Oberlin College. LOUIS FILLER

STONE, MELVILLE ELIJAH (1848-1929), one of the great newspapermen of his day, founded the *Chicago Daily News* in 1876. He made the *Daily News* a leader in journalism. Stone served as general manager of the Associated Press (AP) from 1893 to 1921. As the AP general manager, he helped save the treaty negotiations that ended the Russo-Japanese War in 1905. Stone was born in Hudson, Ill. JOHN TEBBEL

STONE, PRECIOUS. See GEM.

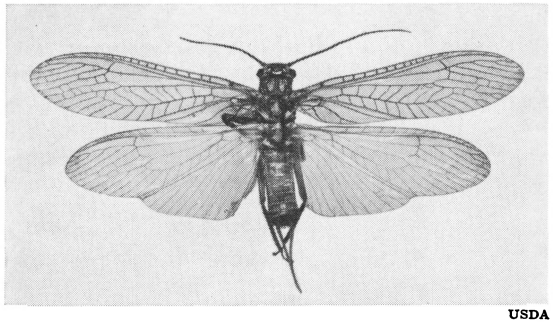
STONE, THOMAS (1743-1787), was a Maryland signer of the Declaration of Independence. Although he favored independence for the colonists, he urged negotiation with Great Britain instead of war. Stone served in the Second Continental Congress and helped frame the Articles of Confederation. He was elected to the Maryland Senate three times. He died during his third term. Stone was born in Charles County, Maryland, and studied law at Annapolis. RICHARD B. MORRIS

STONE AGE is a term used to designate the period in all human cultures when men used stone, rather than metal, tools. The Stone Age began more than 2½ million years ago when human beings first began to make crude chopping tools from pebbles. It first ended in Mesopotamia and Egypt about 3000 B.C., when people began to use bronze (see BRONZE AGE).

Scientists divide the Stone Age on the basis of toolmaking techniques into three phases—*Paleolithic*, *Mesolithic*, and *Neolithic*. The Paleolithic, or Old Stone Age, includes the prehistory of man until about 8000 B.C. All Paleolithic peoples were hunters. Mesolithic, or Middle Stone Age, groups were hunters who lived after 8000 B.C. Neolithic, or New Stone Age, peoples were farmers with specialized equipment. Mesolithic and Neolithic peoples lived during the same general period, but in different parts of the world. For more information, see PREHISTORIC MAN.

Many peoples were still in the Stone Age when Europeans began their voyages of exploration and discovery in the A.D. 1400's. The aborigines of Tasmania and Australia were using techniques of the Old Stone Age when white men discovered them in the 1700's. White men found the African Bushmen living in the Middle Stone Age. Islanders of the South Pacific Ocean and most American Indians had progressed to the New Stone Age. A few tribes in New Guinea and Australia are still in the Stone Age. CARLETON S. COON

See also CITY (How Cities Began and Developed; picture: Neolithic Villages).



USDA

The Stone Fly Is Usually Found Near Brooks or Streams.

STONE FLY is a weak-flying insect. Stone flies are usually found in great numbers along the shores of moving water, where they breed. The name stone fly refers to the fact that the *nymphs* (young) live under stones until they mature. Trout and other game fish eat the nymphs. Adult stone flies vary in color to match their surroundings. They may be $\frac{1}{2}$ to $2\frac{1}{2}$ inches (1.3 to 6.4 centimeters) long. They feed on water insects and plants.

Scientific Classification. Stone flies make up the order *Plecoptera*. E. G. LINSLEY

STONE FRUIT. See FRUIT (picture: Kinds of Fruits).

STONE MARTEN. See FUR (Names of Furs).

STONE MOUNTAIN is a huge, rounded mass of light-gray granite, about 16 miles (26 kilometers) east of Atlanta, Ga. (see Georgia [physical map]). It is the largest stone mountain in North America. At its highest point it rises over 700 feet (210 meters) above the surrounding terrain. It measures about 2 miles (3.2 kilometers) long and 1 mile (1.6 kilometers) wide. On clear days, it can be seen from 30 miles (48 kilometers) away. Stone Mountain supports an exotic vegetation. A kind of cactus plant grows on thin pockets of soil which lie on top of the solid granite.

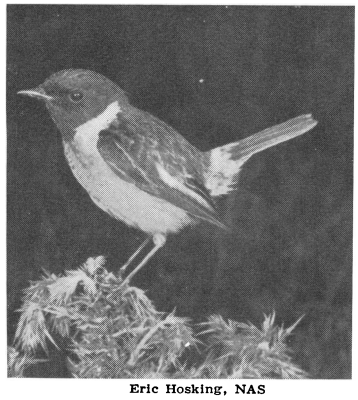
In 1923, an ambitious sculpturing project was undertaken on Stone Mountain. It was designed as a memorial to the heroic struggle of the South during the Civil War. That same year, Congress authorized the minting of a Stone Mountain half dollar in connection with the project. Gutzon Borglum was the first sculptor to work on the monument, but he left Stone Mountain and later began working on the famous Mount Rushmore carvings (see BORGLUM, GUTZON). Henry A. Lukeman also worked on the project. The work was discontinued in 1928 because of lack of funds.

In 1958, Georgia purchased 1,613 acres (653 hectares), including Stone Mountain, to establish a state park there. DeKalb County donated another 400 acres (160 hectares). Since then, the state has bought more land, and the park's area now totals 3,200 acres (1,290 hectares). The park features a lake at the base of Stone Mountain and a skylift that can carry 50 persons to the top. Other features include a beach, a golf course, museums, trails, and a restored plantation.

In 1964, work on the sculpturing project was resumed under the direction of a new sculptor, Walker Kirtland Hancock. The sculpturing of the figures was completed in 1969. The sculpture includes Jefferson Davis, Robert E. Lee, and Stonewall Jackson, on horseback. The figures are so large that when the Lee carving was unveiled, 30 persons could get on the shoulder. A picture of the sculpture appears in the *Visitor's Guide* section of the GEORGIA article. DAVID J. DE LAUBENFELS

STONE OF DESTINY. See SCONE, STONE OF.

STONECHAT is the name of a small European bird of the thrush family. Its name comes from its peculiar note, a sound like that of two stones struck together. The male has a black head and throat and chestnut underparts. The female is duller in coloring. The stonechat is restless and active, and usually lives in open, grassy locations. It builds its nest on the ground, under a tuft of grass, and feeds on insect larvae, worms, beetles, and seeds. It lays from four to six greenish-blue, faintly spotted eggs. The bird winters in Africa.



Eric Hosking, NAS

The Stonechat gets its name from its peculiar call.

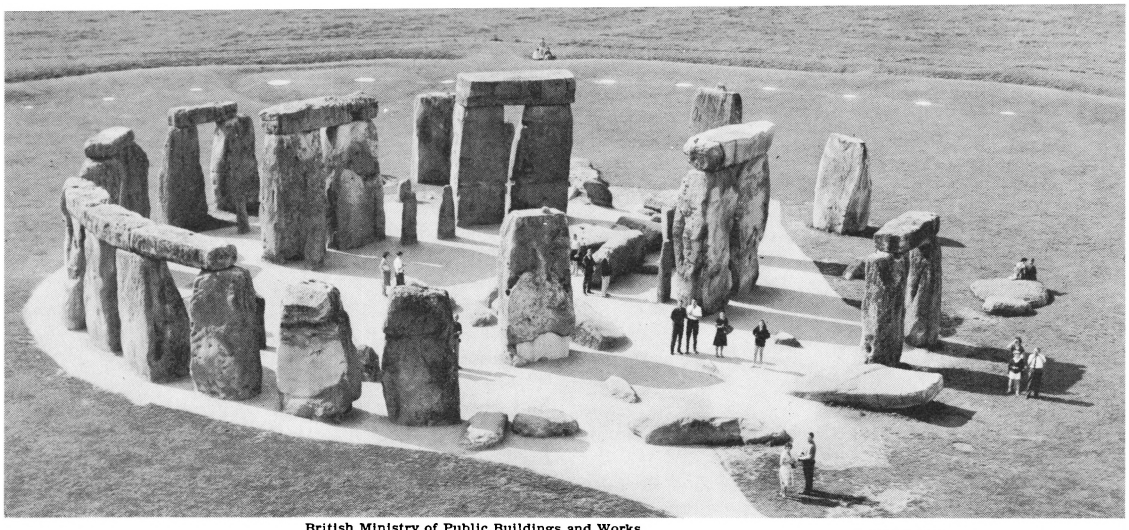
Scientific Classification. The stonechat belongs to the thrush family, *Turdidae*. It is genus *Pratincola*, species *P. rubicola*. LEONARD W. WING

STONECROP. See SEDUM.

STONEHENGE, *STOHN henj*, is an ancient monument on Salisbury Plain in Wiltshire, England. It is a group of huge, rough-cut stones. No one knows exactly who placed them there.

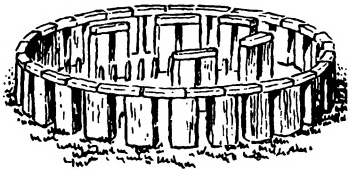
In 1950, archaeologists from Edinburgh University discovered two underground holes which had probably served as ritual pits. Charcoal from one of the pits was found to date from 1848 B.C., plus or minus 275 years, after being analyzed by the radio-carbon dating method. Carvings found on the stones in 1953 also indicate that the stones may be more than 3,500 years old. Some stones are of a kind found only in western Wales, about 300 miles (480 kilometers) away. The stones were probably carried to the site.

For hundreds of years, the great stones gradually fell, or people carried them away to make bridges and mill dams. But from the positions of many of the stones still in place, scholars can guess what the monument probably looked like originally. An earth wall about 320 feet (98 meters) in diameter surrounded the monument. Thirty blocks of gray sandstone, each standing about $13\frac{1}{2}$ feet (4 meters) above the ground and averaging 28 short tons (25 metric tons) stood in a circle about 97 feet (30 meters) in diameter. A continuous circle of smaller blocks stood on top of them. Inside was a circle of about 60 blue stones. Inside this circle were two horseshoe-shaped sets of stones, one inside the other, opening toward the northeast. Near the center curve of the inner horseshoe was a flat sandstone block 16 feet (5 meters) long. This was probably an altar, and may have stood upright. A stone marker 80 yards (73 meters) east of the altar was set to cast a shadow on it at dawn of the summer solstice, about June 21. For this reason, some scholars believe that Stonehenge was connected with sun worship.



British Ministry of Public Buildings and Works

The Monument at Stonehenge, *above,* may have been an ancient astronomical observatory. Scientific studies have shown that the positions of the huge stone slabs indicate the places on the horizon where the sun and moon rise and set about June 21 and December 21. The drawing, *right,* shows what scholars believe was the original arrangement of the stones.



In 1963, Gerald S. Hawkins of the Smithsonian Astrophysical Observatory calculated the directions of lines joining various stones at Stonehenge. He found that the monument may have served as an accurate astronomical calendar, capable of predicting the seasons of the year and even eclipses of the sun and moon. Using an electronic computer, he found a remarkable correlation between the directions of these lines and the directions of the rising and setting of the sun and moon about 1500 B.C. The chances of such correlations being coincidental is about one in 100 million.

In 1922, the British government began to restore Stonehenge. Some of the scattered stones were put back as they had been originally. The government now takes care of this monument. Woodhenge, also in Wiltshire, is a 3,000-year-old wooden monument similar to Stonehenge. ROBERT S. HOYT

STONEHILL COLLEGE. See UNIVERSITIES AND COLLEGES (table).

STONES RIVER, BATTLE OF. See CIVIL WAR (Murfreesboro, or Stones River).

STONEWALL JACKSON. See JACKSON, STONEWALL.

STONEWARE is a type of pottery used for jugs, crocks, various types of heavy dishes, and vessels for chemicals. Stoneware is hard and strong. Potters use clays that they can bake in great heat. Heat causes stoneware to *vitrify* (become glossy). This ware does not absorb liquids and it does not leak. Stoneware does not need expensive glazes, although sometimes potters apply colored glazes.

Many large, thick-walled vessels used in factories, hotels, restaurants, and on farms are made of stoneware. They are used for mixing and storing food. Stoneware is also used for art pottery.

Early American stoneware included such articles as churns, butter pots, bean pots, mugs, jugs, and pitchers. Sometimes the potters applied designs in cobalt blue. Large potteries in Ohio and West Virginia make most of the stoneware produced today. EUGENE F. BUNKER, JR.

See also POTTERY.

STONY BROOK, STATE UNIVERSITY OF NEW YORK AT. See UNIVERSITIES AND COLLEGES (table [New York, State University of]).

STOPE. See MINING (Mining Terms).

STORAGE BATTERY. See BATTERY.

STORE. See BUSINESS; CHAIN STORE; COOPERATIVE; DEPARTMENT STORE; FOOD (Marketing).

STORIED PROVINCE. See QUEBEC (province).

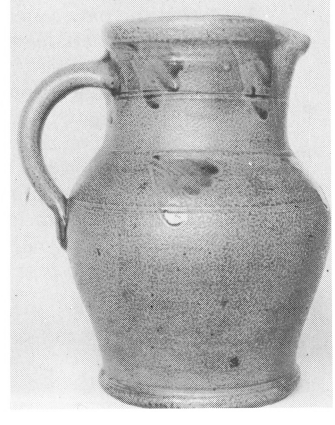
STORK is a large bird with long legs and strong wings. It looks for its food in marshes and swamps, but often nests on roofs and chimneys.

The best-known stork is the *white stork.* It lives in most parts of Europe and Central Asia in the summer and in Africa and northern India in the winter. It is white with black markings on its wings. Its beak is red and its legs and feet are a reddish pink. A pair of storks will return to a nest year after year. Storks eat eels, frogs, reptiles, young birds, and small mammals.

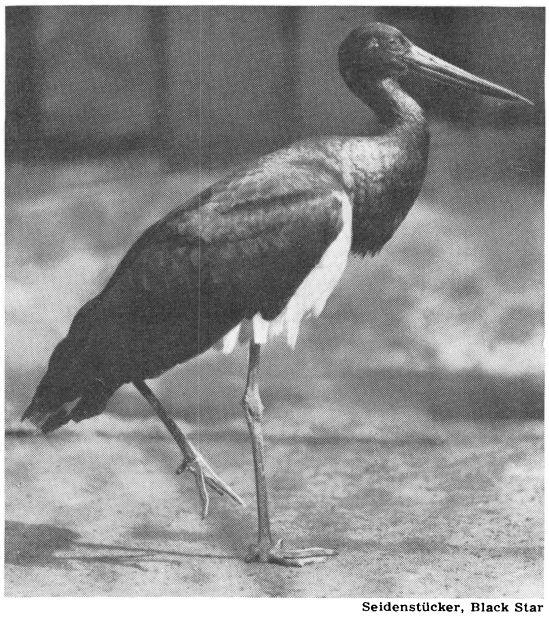
Other storks of the Eastern Hemisphere are the *Japanese stork,* the *black stork,* the *white-necked stork,* and the *adjutant.* The *maguari* and the *jabiru,* a bird 5 feet (1.5 meters) high, are found in South America. The *wood stork* of the southern United States, formerly called the *wood ibis,* is also a true stork.

Stoneware has been a popular type of pottery for many years. The English salt-glazed stoneware figure, *left,* was made about 1750. The American pitcher, *right,* was made in the 1800's.

Metropolitan Museum of Art



Black Star



Seidenstücker, Black Star

The White Stork, *left,* **seeks out cities and towns with chimneys and crannies in which to nest. It rears its family in such high places. The black stork,** *above,* **shuns such nesting places.**

The stork is a respected and protected bird in many places. The Germans and the Dutch like storks because they destroy insects and reptiles. They also believe that the stork brings good luck. The faithfulness of a pair of storks is considered a model of married happiness. The familiar legend that the stork brings the new baby into the home arises from the fact that the stork takes loving care of its own young.

Scientific Classification. The stork belongs to the stork family, *Ciconiidae.* The white stork is classified as genus *Ciconia,* species *C. ciconia.* ALFRED M. BAILEY

See also ADJUTANT; BIRD (color picture: Birds of Other Lands); JABIRU; MARABOU.

STORM is a disturbance of the atmosphere. Storms are usually marked by strong winds, rain, snow, or hail, or by a combination of two or more of these. Storms would never occur if the temperature of the air everywhere were equal. The air in low latitudes becomes heated, however, while that in high latitudes is cooled. The air over oceans stays warmer in the winter, and cooler in summer, than that over land. These differences in temperature also result in differences in pressure. Over warm areas the pressure remains relatively low, while over colder areas it is high.

As cold air accumulates in the high latitudes, large masses of it tend to spread out toward the equator. Eventually these large masses break off into separate, wandering masses of cold air which move generally eastward and southward. In the middle latitudes, these masses of cold air usually meet warm air masses that have come up from low latitudes. Wherever warm and cold air masses meet, a struggle develops, which may result in storms. Differences in temperature, pressure, and humidity cause all the many different kinds of storms. GEORGE F. TAYLOR

Related Articles in WORLD BOOK include:

Air	Hurricane	Thunder
Barometer	Lightning	Tornado
Blizzard	Rain	Typhoon
Cloudburst	Sandstorm	Waterspout
Cyclone	Sleet	Weather
Dust Storm	Snow	Whirlwind
Hail	Sunspot	Wind

STORM TROOPS. See HITLER, ADOLF (Birth of the Nazi Party); GESTAPO.

STORMALONG, ALFRED BULLTOP, an American folklore character, was the gigantic hero of sailors' tall tales about a huge ship named the *Courser.* The *Courser* was so big that the officers and men on watch rode horseback on deck. Its masts were hinged to bend so they could let the sun and moon pass. Sailors who climbed its rigging as young men came down with gray beards. Stormalong performed amazing feats of seamanship aboard the ship. He suggested soaping the sides of the *Courser* to ease it through the English Channel. It was such a tight squeeze that the soap scraped off on the cliffs of Dover, leaving them white. B. A. BOTKIN

STORMY PETREL. See PETREL.

STORTING. See NORWAY (Parliament).

STORY, JOSEPH (1779-1845), served as an associate justice of the Supreme Court of the United States from 1812 to 1845. As an outstanding member of the Supreme Court, he followed closely in the footsteps of John Marshall (see MARSHALL, JOHN). His *Commentaries,* a series of important legal essays, helped shape American concepts of the common law.

Story was born at Marblehead, Mass., and was graduated from Harvard University in 1798. He began to practice law in 1801 and later served in Congress. He was also a professor of law at Harvard University from 1829 until his death. JERRE S. WILLIAMS

Werner Wolf, Black Star

A Storytelling Session fascinates a group of young listeners. This teacher helps the children follow the action of a story in a picture book.

STORYTELLING is one of the oldest forms of folk art. Like dancing and singing, it grew out of man's need to share his emotions and experiences.

Historically, all literature developed from storytelling. Today, storytelling is generally considered one of the most effective ways to introduce children to literature. Most children delight in listening to stories. The experience helps many youngsters learn to love literature and may lead to a lifetime habit of reading.

Storytelling as an art means recreating literature—taking the printed words in a book and giving them life. A good story does more than merely please the listener. By listening, a child may learn how to express his own thoughts. Research has shown that storytelling and other oral language activities expand children's language skills significantly. Studies also have shown a close relationship between the ease with which a child learns to read and his experience of having stories read to him.

The importance of storytelling is perhaps best expressed by the great Russian poet-storyteller Kornei Chukovsky. In his book *From Two to Five*, Chukovsky wrote:

"The goal of storytellers consists of fostering in the child . . . compassion and humaneness—this miraculous ability of man to be disturbed by another being's misfortunes, to feel joy about another being's happiness, to experience another's fate as one's own.

"Storytellers take trouble to teach the child in his early years to participate with concern in the lives of imaginary people and animals, and to make sure that in this way he will escape the narrow frame of his egocentric interests and feelings.

"Because it is natural for a child to be on the side of the kind, the courageous, and the unjustly offended when listening to a fairy tale, whether it is Prince Ivan or Peter Rabbit or the Fearless Spider, our only goal is to awaken, nurture, and strengthen in the responsive soul of the child this invaluable ability to feel compassion for another's unhappiness and to share in another's happiness. Without this, a man is inhuman."

How to Tell Stories

Selection of a story to tell—or to read aloud—is very important. A story should be worth listening to and worth the time it takes to prepare. You can share only what you yourself enjoy and appreciate.

Picture-book stories should be read aloud rather than told, because the illustrations are part of the story. When sharing a picture book with a group of children, hold the book in one hand with the pictures facing

Ellin Greene, the contributor of this article, is the editor of Stories: A List of Stories to Tell and to Read Aloud. *Augusta Baker, who served as consultant, is Coordinator of Children's Services for The New York Public Library.*

the children. Turn the pages with your free hand. You need not memorize the text, but you must know the story well enough to read it by just glancing at the pages. In selecting picture books to use with a group, look for large, clear pictures; flowing language; and a strong story line.

Children up to the age of 6 take pleasure in simple, realistic stories because everyday happenings may be new to them. They also like nursery rhymes, the tales of Beatrix Potter, and the imaginative stories of Maurice Sendak.

Children from 6 to 8 enjoy folk tales. Many folk tales have been published in attractive picture-book editions. Folk tales combine economy of language with plenty of action. They deal with universal truths, and their wisdom is meaningful to children.

Boys and girls older than 8 like tall tales, adventure stories, and myths and legends. Modern books of fantasy lend themselves to storytelling and reading aloud. Poetry, starting with the rollicking nonsense verse of Mother Goose for the youngest children, appeals to all youngsters (see POETRY).

Preparation. Before telling a story that has no pictures, read the tale to yourself several times. Visualize how the characters look, the clothing they wear, and how they act. Then imagine the action of the story as if seeing it in a series of pictures.

In preparing a folk or fairy tale, you should distinguish between a traditional tale and a literary tale. A traditional tale has many versions. If you wish, you may retell parts of the story in your own words. However, you should be familiar enough with these tales to express their rhythmic patterns. A literary tale is created by one author. Such stories can achieve their desired effect only if they are told in the words of the author. Therefore, you should know these tales thoroughly.

Read the story aloud to get used to the sound of your voice. Listen for basic rhythmic patterns. Feel the mood of the story. Each story has its own mood, which will affect the pace of your telling. Finally, tell the story without the book. While doing this, stand or sit in front of a mirror so you can detect and eliminate any distracting mannerisms. After you feel at home with the story, you are ready to share it with children.

Telling a Story. Stories may be told anywhere—at home, on the playground, in the classroom, or in the library. Whatever the surroundings, the storyteller should give children the feeling that listening to a story is something special.

Make the children as physically comfortable as possible. If you are telling a story to more than two or three youngsters, seat them in a semicircle in front of you. Do not expect children to listen too long. From 15 to 20 minutes is long enough for young children, and 30 minutes is fine for older ones.

With no book between you and the children, you can concentrate on their reactions to the story. You can respond to their mood and adjust your pace to their needs. The children are free to create their own images, making mental pictures that fit the words they hear. It is seldom necessary to explain the meanings of words. But if the children seem puzzled the second or third time they hear an unfamiliar word, interpret it for them. Let your own pleasure in the story come through as you tell it. Enthusiasm is contagious.

A storyteller should not pry into a child's feelings about a story by asking questions that demand responses. You may think a child is not listening. But you may be surprised a few weeks later to hear him comment on the story or to ask to hear it again.

History

The Earliest Storytelling probably consisted of a simple chant in praise of the dawn or of the stars. Other early storytelling chants were sung to accompany some task, such as grinding corn or sharpening tools or weapons.

As man began to wonder about the world around him, he composed songs in tribute to the unseen spirits of the earth and sky. Such songs marked the beginning of the mythical tale.

Man told mythical tales by combining stories, poetry, music, and dancing. Much of today's storytelling, including dramatic presentations, combines song, dance, and stories. For example, many storytelling programs on television include folk singing.

In ancient times, the best-liked storyteller was chosen entertainer for the community. He also became the historian of the group.

The Middle Ages. The storyteller's art flourished during the Middle Ages, from about the A.D. 400's to the 1500's. Storytellers were welcome in royal courts as well as in market places. Traveling storytellers journeyed from country to country. They gathered news and learned the favorite stories of various regions as they traveled. Storytellers exchanged tales so often that it became difficult to trace the origin of many of their stories.

The storytellers of the Middle Ages had thorough training. Ruth Sawyer, a noted American storyteller and author of children's books, described the training of a *troubadour*, a poet-musician of that period. She wrote that a good troubadour was expected "to know perfectly all the current tales, to repeat all the noteworthy theses from the universities, to be well informed on court scandal, to know the healing power of herbs and *simples* (medicines), to be able to compose verses to a lord or lady at a moment's notice, and to play on at least two of the instruments then in favor at court."

No one knows how many storytellers entertained during the Middle Ages. Some writings tell that 426 minstrels were employed at the wedding of Princess Margaret of England in 1290. The many minstrels in the court of Edward I included two women who performed under the names of Matill Makejoye and Pearl in the Egg.

With the invention of movable type about 1440, the influence of the professional storyteller faded as reading replaced listening. Inexpensive *chapbooks* (pamphlets of popular tales) not only provided entertainment but also preserved some of the earliest stories. Oral storytelling survived mainly in rural areas.

The 1800's. During the early 1800's, the brothers Jakob and Wilhelm Grimm awakened a scholarly

interest in folk literature with the publication of a collection of German fairy tales. The Grimm collection became probably the best-known work of its kind. The brothers gathered their stories from the common people and faithfully preserved the unique structure and language pattern of the tales. See GRIMM.

Peter Asbjørnsen and Jørgen Moe followed the example of the Grimms and collected Norwegian folk tales (see ASBJØRNSEN, PETER CHRISTEN). In England, Joseph Jacobs searched folklore journals for tales of the British Isles and rewrote them for children.

The 1900's. The interest in collecting folk tales has continued during the 1900's. The American author Harold Courlander has collected African and West Indian tales. Richard Chase, a well-known American folklorist, has collected many American and English tales that are told by the people of the southern Appalachian Mountains.

During the early 1900's, Marie Shedlock, a retired English schoolteacher, specialized in telling the stories of Hans Christian Andersen and the Grimm brothers. Miss Shedlock emphasized the importance of storytelling as a natural way to introduce children to literature. From 1900 to 1920, Miss Shedlock made several lecture tours of the United States, speaking on the art of storytelling to teachers and librarians. Today, many library schools and schools of education offer courses in storytelling.

ELLIN GREENE

Related Articles in WORLD BOOK include:

FAMOUS CHARACTERS AND STORIES

Aesop's Fables	Grimm's Fairy Tales	Mother Goose
Aladdin	Gulliver's Travels	Peter Pan
Arabian Nights	Hiawatha	Rip Van Winkle
Arthur, King	Huckleberry Finn, Adventures of	Robin Hood
Cinderella	Lancelot, Sir	Robinson Crusoe
Courtship of Miles Standish	Lochinvar	Round Table
Evangeline		Santa Claus
Galahad, Sir		Scheherazade

STORYTELLERS

Andersen, Hans C.	Minnesinger	Sawyer, Ruth
Bard	Minstrel	Skald
Grimm (family)	Perrault, Charles	Troubadour
Mastersinger		

OTHER RELATED ARTICLES

Bible (The Bible for Children's Use)	Mythology
Caldecott Medal	New York City (picture: Traveling Storytellers)
Christmas (Literature)	Newbery Medal
Folklore	Nursery Rhyme
Literature for Children	Regina Medal

Books to Read

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ANDERSEN, HANS CHRISTIAN. *The Ugly Duckling.* Tr. by R. P. Keigwin. Illus. by Johannes Larsen. Macmillan, 1955.

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GÁG, WANDA. *Millions of Cats.* Coward-McCann, 1928.

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HALEY, GAIL E. *A Story—A Story. An African Tale.* Atheneum, 1970.

JACOBS, JOSEPH. *Tom Tit Tot.* Illus. by Evaline Ness. Holt, 1965.

LANG, ANDREW, ed. *The Twelve Dancing Princesses.* Illus. by Adrienne Adams. Holt, 1966.

The Old Woman and Her Pig: A Folk Tale. Illus. by Paul Galdone. McGraw, 1960.

PERRAULT, CHARLES. *Puss in Boots.* Illus. by Marcia Brown. Scribner, 1952. *Cinderella, or The Little Glass Slipper.* Illus. by Marcia Brown. 1954.

THURBER, JAMES. *Many Moons.* Illus. by Louis Slobodkin. Harcourt, 1943.

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BAKER, AUGUSTA. *The Golden Lynx and Other Tales.* Illus. by Johannes Troyer. Lippincott, 1960.

BELPRÉ, PURA. *The Tiger and the Rabbit and Other Tales.* Illus. by Tomie de Paola. Lippincott, 1965.

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D'AULAIRE, INGRI and EDGAR PARIN. *East of the Sun and West of the Moon: Twenty-one Norwegian Folk Tales.* Viking, 1969.

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FILLMORE, PARKER. *The Shepherd's Nosegay: Stories from Finland and Czechoslovakia.* Ed. by Katherine Love. Illus. by Enrico Arno. Harcourt, 1958.

FINGER, CHARLES J. *Tales from Silver Lands.* Illus. by Paul Honoré. Doubleday, 1924.

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ROSS, EULALIE STEINMETZ, comp. *The Lost Half-Hour.* Illus. by Enrico Arno. Harcourt, 1963.

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STOUTENBERG, ADRIEN. *American Tall Tales.* Illus. by Richard M. Powers. Viking, 1966.

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Ets, Marie Hall. *Play with Me.* Viking, 1955.

McCloskey, Robert. *Make Way for Ducklings.* Viking, 1941.

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Potter, Beatrix. *The Tale of Peter Rabbit.* Warne, n.d.

Sendak, Maurice. *Where the Wild Things Are.* Harper, 1963.

Tresselt, Alvin. *Hide and Seek Fog.* Illus. by Roger Duvoisin. Lothrop, 1965.

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Yashima, Taro. *Umbrella.* Viking, 1958.

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Farjeon, Eleanor. *The Little Bookroom.* Illus. by Edward Ardizzone. Oxford, 1956.

Grahame, Kenneth. *The Wind in the Willows.* Illus. by Arthur Rackham. Heritage, 1956.

Kipling, Rudyard. *Just So Stories.* Illus. by Nicolas. Doubleday, 1912.

Lewis, C. S. *The Lion, the Witch, and the Wardrobe.* Illus. by Pauline Baynes. Macmillan, 1950.

Norton, Mary. *The Borrowers.* Illus. by Beth and Joe Krush. Harcourt, 1953.

Sandburg, Carl. *The Sandburg Treasury.* Introd. by Paula Sandburg. Illus. by Paul Bacon. Harcourt, 1970. Prose and poetry consisting of *Rootabaga Stories, Early Moon, Wind Song, Abe Lincoln Grows Up,* and *Prairie-Town Boy.*

Tolkien, J. R. R. *The Hobbit.* Houghton, 1938.

White, E. B. *Charlotte's Web.* Illus. by Garth Williams. Harper, 1952.

Wilder, Laura Ingalls. *Little House in the Big Woods.* Illus. by Garth Williams. Harper, 1953.

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Bontemps, Arna, comp. *Hold Fast to Dreams.* Follett, 1969.

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Cole, William, comp. *The Birds and the Beasts Were There: Animal Poems.* Illus. by Helen Siegl. World, 1963.

De la Mare, Walter, comp. *Come Hither.* Knopf, 1957.

Hughes, Langston. *The Dream Keeper and Other Poems.* Illus. by Helen Sewell. Knopf, 1932.

Lear, Edward. *The Owl and the Pussycat.* Illus. by Barbara Cooney. Little, 1969.

Lewis, Richard, comp. *Miracles: Poems by Children of the English-Speaking World.* Simon & Schuster, 1966. *Out of the Earth I Sing: Poetry and Songs of Primitive Peoples of the World.* Norton, 1968.

McCord, David. *Far and Few: Rhymes of the Never Was and Always Is.* Illus. by Henry B. Kane. Little, 1952.

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Greene, Ellin. *Stories: A List of Stories to Tell and to Read Aloud.* 6th ed. The New York Public Library, 1965.

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Shedlock, Marie L. *The Art of the Storyteller.* Dover, 1952.

Tashjian, Virginia. *Juba This and Juba That: Story Hour Stretches for Large or Small Groups.* Little, 1969.

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The Pleasure Is Mutual: How to Conduct Effective Picture Book Programs. 16mm, color, 24 min. Distributed by the Children's Book Council, Inc., 175 Fifth Avenue, New York, N.Y. 10010.

There's Something About a Story: The Enjoyment of Storytelling in One Community. 16mm, color, 27 min. Produced and distributed by Connecticut Films, Inc., 6 Cobble Hill Road, Westport, Conn. 06880.

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STOSS, *shtohs,* **VEIT** (1440?-1533), was a German sculptor. His works have a rich, complex appearance and a clear pattern. Stoss and his fellow German sculptor Tilman Riemenschneider used a late Gothic style. Both used Christian themes almost entirely, but Stoss's work is more dramatic and expressive than Riemenschneider's.

Stoss was born in Germany, and received his early training there. He went to Kraków, Poland, in 1477 and worked there for almost 12 years on what is probably his masterpiece. It is an altar over 42 feet (13 meters) high and 36 feet (11 meters) wide in the Church of St. Mary representing the life of the Virgin. Stoss later settled in Nuremberg, Germany. Robert R. Wark

STOUT. See Beer.

STOUT, REX TODHUNTER (1886-), is an American detective-story writer. He created the fat, beer-drinking, orchid-loving detective Nero Wolfe. Wolfe stays home and sends his able assistant Archie Goodwin out for clues. Later, while sitting with a glass of beer and a potted orchid, Wolfe solves the mystery. Wolfe first appeared in *Fer-de-Lance* (1934). Stout's many other Nero Wolfe mysteries include *The League of Frightened Men* (1935), *Before Midnight* (1955), and *A Right to Die* (1964).

Stout was born in Noblesville, Ind. He devised a school banking system which he set up in about 400 cities and towns between 1917 and 1927. Profits from the system made him wealthy and enabled him to devote his time to writing. Stout published his first novel in 1929. Philip Durham

WORLD BOOK photos

Modern Ranges cook with gas or electricity. The gas range in the top picture has burners on the cooktop and in the oven beneath it. The electric range shown above has an eye-level oven, heating units on the cooktop, and a second oven under the cooktop.

STOVE is an appliance that provides heat for cooking or for warming a room. Cooking stoves are called *ranges*. A range has a cooktop with several heating areas, and one or two ovens. This article deals mainly with ranges. Few heating stoves are still used in Canada or the United States.

There are two chief kinds of ranges: (1) electric ranges and (2) gas ranges.

Electric Ranges have *heating units*, in which an electric current generates heat. Most electric ranges have four circular heating units on the cooktop and one or two rectangular units in each oven.

Most heating units have an outer surface that consists of a metal tube. The tube encloses a coil of wire. Electricity passes through the coil and heats the coil and the metal tube. A packing material around the coil prevents electricity in the coil from reaching the outer tube. Without this protection, the heating unit would be unsafe.

The amount of heat produced by a heating unit can be regulated easily. Some cooktop units have controls that regulate the watts of electricity supplied to the coil. The greater the wattage, the hotter the coil becomes. Another kind of cooktop unit control turns the current on and off at intervals that vary with the heat desired. The longer the current flows through the unit, the higher the heat. Most oven units are regulated by thermostats, and some cooktop units also have thermostatic controls (see THERMOSTAT).

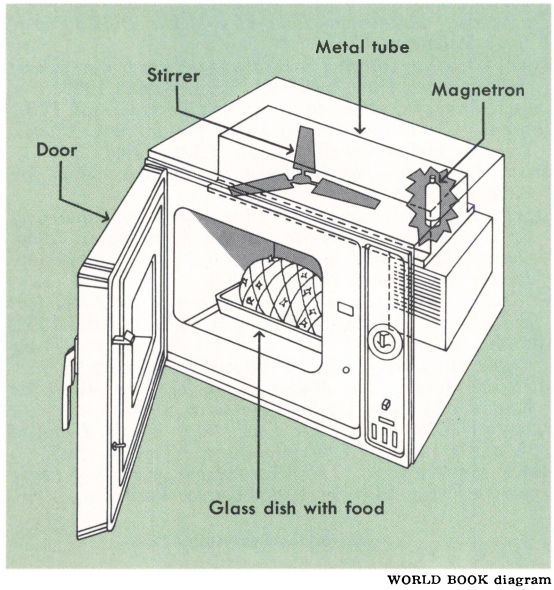
Gas Ranges have *burners* on the cooktop and in each oven. A burner mixes air with natural gas or *LP-gas* (liquefied petroleum gas). The resulting mixture flows through small holes in the burner. The flowing gas is ignited into a flame by a spark produced by a built-in electric device, or by a *pilot light* near the burner. A pilot light is a small flame that burns continuously.

The heat produced by a burner depends mainly on the rate at which the flowing gas reaches the flame. A valve regulates the gas flow to each burner. Hand-operated valves control most cooktop burners. Thermostats operate the valves of most oven burners and of some cooktop burners.

Microwave Ovens cook food by using short radio waves that penetrate the food and make its molecules vibrate. Friction among the moving molecules produces heat, which cooks the food. Microwaves pass through glass, paper, and most kinds of china without heating them. Therefore, containers made of those materials may be used to hold food during microwave cooking. In addition, microwaves bounce off metal without warming it.

A microwave oven has an electronic vacuum tube called a *magnetron* that produces microwaves. In most such ovens, the microwaves travel through a metal tube to the metal blades of a *stirrer*, a device similar to an electric fan. The moving blades scatter the microwaves into the oven, which has metal walls. The waves bounce from wall to wall until they enter the food in the oven.

Microwave cooking generally takes much less time than cooking with electric heating units or gas burners.



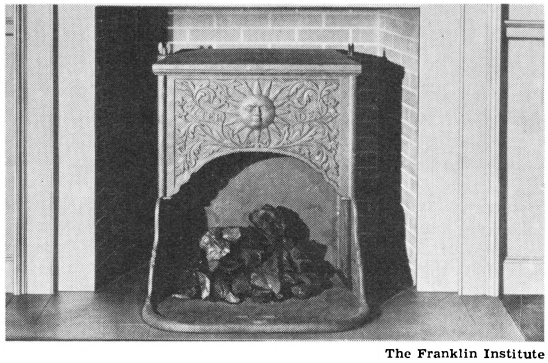
WORLD BOOK diagram

A Microwave Oven has an electronic vacuum tube called a *magnetron* that produces microwaves. The waves travel through a metal tube to the stirrer, which scatters them into the oven. In the oven, the microwaves penetrate food and cook it quickly.

But the time needed depends on the amount of food being cooked. For example, a regular oven takes from 45 minutes to an hour to bake one or several potatoes. A microwave oven can bake one potato in about three minutes. But it requires an extra two minutes of cooking time for each additional potato.

History. People in northern China used earthenware stoves for heating as early as the 700's. Europeans began to use such stoves in the 1400's.

The first stoves produced in the American Colonies were made in the Massachusetts city of Lynn in 1642. They were little more than cast-iron boxes with lids. The American statesman and inventor Benjamin Franklin developed the Franklin stove in the early 1740's. This stove, a cast-iron enclosure, fitted into a fireplace. It extended into the room so that three sides gave off heat. The first practical cooking stove was designed in the 1790's by Benjamin Thompson, Count Rumford, a British statesman and inventor. This stove, a boxlike brick structure, had holes in the top to hold pots.



The Franklin Institute

The Franklin Stove shown above was built from plans that the American statesman and inventor Benjamin Franklin drew in 1744.

Crown Stove Works; Chambers Corporation; Crown Stove Works

Stoves of the Past. A cast-iron range of the late 1800's burned coal, coke, or wood. A 1925 gas range had an oven next to the cooktop. A "potbelly" baseburner of the late 1800's burned hard coal to heat a room.

Until the early 1800's, most people in Canada and the United States used fireplaces for cooking and heating. During the 1830's, advances in ironmaking and transportation made cast iron widely available. As a result, iron cookstoves and heating stoves became popular. Most of these early stoves burned wood. The first practical coal stove, called a *baseburner*, was patented in 1833 by Jordan L. Mott, an American inventor. This stove had ventilation so it could burn coal efficiently.

In 1855, Robert W. Bunsen, a German chemist, invented the first practical gas burner. In the 1860's, ranges based on Bunsen's burner became popular in cities that had gas piped into homes for use in gaslights. People in rural areas began to use gas ranges after 1910, when gas became available in pressurized containers.

Electric ranges were first sold in 1909. Early electric stoves cooked extremely slowly, and few people bought them. After the modern cooking unit was developed in 1930, electric ranges became popular. Microwave ovens were introduced in the mid-1950's. ELIZABETH BEVERIDGE

STOWE, HARRIET BEECHER (1811-1896), is remembered chiefly for her antislavery novel, *Uncle Tom's Cabin*, published in 1851. When most people think of the book's famous characters, Uncle Tom, Little Eva, Topsy, and Simon Legree, however, they are not remembering the book. They are thinking instead of George L. Aiken's play of 1852, or those crude and violent spectacles, the "Tom Shows," which played small towns in the North. Aiken's play and the Tom Shows only faintly suggest Mrs. Stowe's book. *Uncle Tom's Cabin* is melodramatic and sentimental, but it is more than a melodrama. It re-creates characters, scenes, and incidents with humor and realism. It analyzes the issue of slavery in the Midwest, New England, and the South during the days of the Fugitive Slave Law. The book intensified the disagreement between the North and the South which led to the Civil War. Mrs. Stowe's name became hated in the South.

Other Works. Mrs. Stowe's works, dealing with New England in the late 1700's and early 1800's, are important for anyone who wants to understand the American past. These include *The Minister's Wooing* (1859) and *Oldtown Folks* (1869), both novels; and *Sam Lawson's Oldtown Fireside Stories* (1872), a collection of stories. They present everyday life of the New England village, and make clear the positive and negative aspects of Puritanism. As in *Uncle Tom's Cabin*, the characters come alive to the reader as soon as they begin to talk.

Brown Bros.

Harriet Beecher Stowe

Of her later books, the most shocking to her contemporaries was *Lady Byron Vindicated* (1870). It told of Lady Byron's separation from her husband,

the famous poet, Lord Byron. Mrs. Stowe's account was based on Lady Byron's talk with her in 1856, and is supported by later investigation.

Her Life. Mrs. Stowe was born on June 14, 1811, in Litchfield, Conn., where her father, Lyman Beecher, was minister of the Congregational Church. She was educated at the academy there and at Hartford Female Seminary. From 1832 to 1850 she lived in Cincinnati, Ohio, where her father served as president of Lane Theological Seminary. In 1836, she married Calvin Stowe, a member of the Lane faculty. Her years in Cincinnati furnished her with many of the characters and incidents for *Uncle Tom's Cabin*, which she wrote in Brunswick, Me. After the publication of the book, Mrs. Stowe became famous overnight. On a visit to England, she was welcomed by the English abolitionists.

Mrs. Stowe was the mother of seven children, and the sister of the clergyman Henry Ward Beecher and the reformer and educator Catharine Beecher (see BEECHER). CHARLES H. FOSTER

See also ABOLITIONIST; UNCLE TOM'S CABIN.

STRABISMUS. See CROSS-EYE.

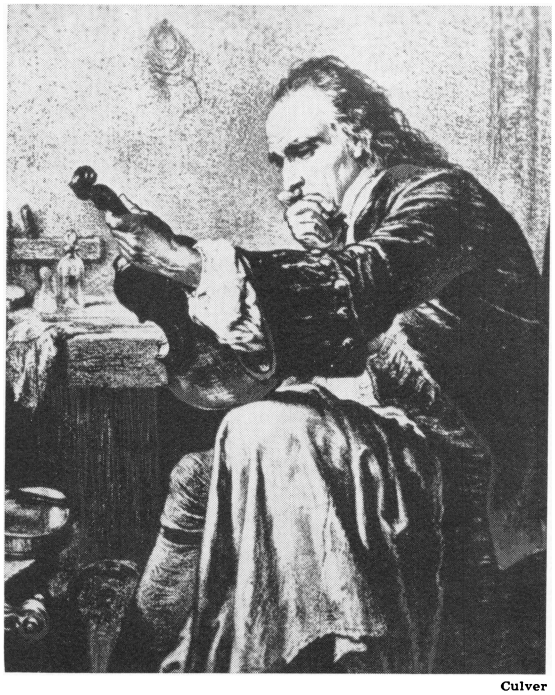
STRABO, *STRAY boh* (63 B.C.?-A.D. 24?), was a Greek geographer and historian. He became famous for his 17-volume *Geography*, which described all parts of the known world. These volumes are the best source of geographical information about the Mediterranean countries at the beginning of the Christian Era. Strabo also wrote a lengthy history that is now lost. He was born in Amasia, Pontus. He studied in Rome and Alexandria, and traveled in Arabia, southern Europe, and northern Africa. J. RUSSELL WHITAKER

STRACHEY, LYTTON (1880-1932), was an English biographer, essayist, and literary critic. His best-known works are biographies—*Eminent Victorians* (1918) and *Queen Victoria* (1921). *Eminent Victorians* is a group of sketches about four famous figures of Victorian England—the educator Thomas Arnold, General Charles Gordon, Henry Cardinal Manning, and the nurse Florence Nightingale. Strachey's biographical portraits are brief but thorough. They provide a clever mixture of fact, imagination, and psychological analysis.

Giles Lytton Strachey was born in London. He formed most of his ideas and lifelong friendships while studying at Cambridge University from 1899 to 1903. Strachey gained a place in the center of London literary life through the wit, elegance, and skeptical nature of his personality and writings. Strachey and his Cambridge friends formed the nucleus of what became known as the Bloomsbury Group (see BLOOMSBURY GROUP). This group included some of the leading English intellectuals of the day. DARCY O'BRIEN

STRADIVARI, *STRAH dee VAH ree,* **ANTONIO** (1644?-1737), in Latin, ANTONIUS STRADIVARIUS, was one of the greatest violinmakers of all time. He made his finest instruments between 1700 and 1725. They were not only brilliant in tone and power, but also had excellent form and were exact in every detail. At the time of his death, many unfinished instruments were found in his workshop. These were completed either by his sons or by his pupils, but his name appeared on the labels.

Prices of genuine Stradivari violins now range from about $15,000 to $65,000. Unsuspecting purchasers have been deceived into buying instruments which have the outward appearance of his violins. But scholars estimate that Stradivari made 1,116 instruments, and of these instruments only a very few genuine specimens remain.



Culver

Stradivari at Work on a Violin in the early 1700's. This Italian made such perfect violins that today they are worth many thousands of dollars. It is the ambition of almost every concert violinist to own a Stradivari instrument.

Stradivari's birthplace is not known, but he was an Italian. As a boy, he was apprenticed to Nicolo Amati, the famous master of violinmaking. By 1666, Stradivari was making violins under his own label. DOROTHY DELAY

See also AMATI; VIOLIN.

STRAFFORD, EARL OF (1593-1641), THOMAS WENTWORTH, was an English statesman. From 1614 to 1628 he was a leader of Parliament in its struggle with the Stuart kings. He was not a Puritan, however, and gradually drew away from his parliamentary friends as they became more vigorous in their criticism of King Charles I. In 1628, he went over to the king's side and in 1633, became Lord Deputy of Ireland. His administration was extremely harsh.

Wentworth returned to England in 1639. He became one of King Charles' chief advisers in his struggle against Parliament. Parliamentary leaders saw him as the greatest threat to their safety, and in 1640 decided to impeach him. He returned to London on Charles I's guarantee of safety. But, instead of an impeachment, Parliament passed a bill of attainder (see ATTAINDER). Charles, fearing mob violence, signed it, and two days later Strafford was executed. W. M. SOUTHGATE

STRAIGHT TICKET. See VOTING MACHINE; BALLOT.

STRAIN. See STRENGTH OF MATERIALS; ELASTICITY.

STRAIT is a narrow channel of water between two large bodies of water. Many wars have been fought and

many treaties negotiated for the control and use of the world's important straits. Well-known straits include the Strait of Gibraltar between the Atlantic Ocean and the Mediterranean Sea, and the straits of Bosporus and Dardanelles between the Mediterranean and Black seas. The Strait of Magellan at the tip of South America is the only strait between the Atlantic and Pacific oceans. SIGISMOND DER. DIETTRICH

See also the separate articles in WORLD BOOK on the various straits, such as GIBRALTAR, STRAIT OF.

STRAITS SETTLEMENTS, in southeastern Asia, were part of colonial British Malaya. The British East India Company formed the settlements in 1826. They included Singapore, Malacca, Penang-Wellesley, and the islands of the Dindings district. The mainland of the Dindings district was added in 1874. Christmas Island joined the settlements in 1900. The Cocos Islands joined in 1903, and Labuan Island joined in 1907. During World War II, the settlements and Malaya were occupied by the Japanese.

The Straits Settlements colony was dissolved in 1946. Singapore, with Cocos and Christmas islands, became a separate colony, and Labuan Island was added to North Borneo. In 1957, the British ceded Penang and Malacca to the Federation of Malaya. In 1963, the former Straits Settlements, Malaya, Singapore, Sarawak, and Sabah (North Borneo) merged to form the Federation of Malaysia. Singapore became an independent country in 1965. GEORGE F. DEASY

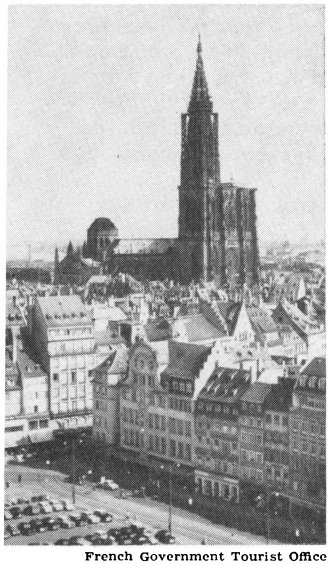
STRAMONIUM. See JIMSON WEED.

STRAND. See LONDON (Central London).

STRANGLES. See DISTEMPER.

STRANGULATION. See FIRST AID; HERNIA.

STRASBOURG, *strahz BOOR*, or *STRAS burg* (pop. 249,396; met. area 334,668), is a trading center in France. Its location on the Ill River and its canal link with the Rhine make it a major "ocean port." It stands 250 miles (402 kilometers) east of Paris (see FRANCE [political map]). Its plants produce beer, tobacco, leather, petroleum, and automobiles.



French Government Tourist Office

Strasbourg's Cathedral is one of Europe's most famous Gothic buildings. The spire is about 465 feet (142 meters) high. Work on the cathedral started in the 1000's.

Strasbourg is an old city with many examples of medieval buildings. The Gothic cathedral, with its famous clock and magnificent rose window, is one of the most beautiful in Europe. Strasbourg University was founded in 1538.

The location of Strasbourg near the German-French border has made the city important commercially, but it has also made it a prize of war for many years. It was a German free town until 1681, when it was united with France. During the French Revolution in 1792, "The Marseillaise," the French national anthem, was written in Strasbourg. After the Franco-Prussian War in 1870, France ceded Strasbourg to Germany. The city became French again after the Treaty of Versailles in 1919. German troops occupied it in 1940, and Allied troops freed it in 1944. Strasbourg has been the headquarters of the Council of Europe since 1949. EDWARD W. FOX

See also ARCHITECTURE (Gothic [picture]); ALSACE-LORRAINE.

STRASS. See GEM (Imitation and Artificial).

STRASSMANN, FRITZ (1902-), is a German radiochemist. With Otto Hahn, another German radiochemist, he split the uranium atom in 1938. Strassmann and Hahn bombarded uranium atoms with neutrons and produced an element that they identified as barium. The importance of their work was revealed in 1939 by the Austrian physicists Lise Meitner and Otto R. Frisch. Meitner and Frisch explained that the neutrons had split the uranium atoms into fragments, producing barium and other elements.

Strassmann was born in Boppard, Germany. He taught at a technical high school in Hannover. In 1929, he joined Otto Hahn's laboratory staff in the Kaiser Wilhelm Institute for Chemistry (now Max Planck Institute) in Berlin-Dahlem. AARON J. IHDE

See also ATOM (Splitting the Atom); HAHN, OTTO; MEITNER, LISE.

STRATEGIC AIR COMMAND (SAC) is the long-range bomber and missile force of the United States Air Force. Its combat-ready air forces can strike anywhere in the world. SAC includes the Second, Eighth, Fifteenth, and Sixteenth air forces. It has about 1,300 jet bombers and tanker airplanes. SAC uses several types of missiles, including intercontinental ballistic missiles. SAC's communications network can mobilize the entire command within seconds after a warning. A bomber force can be on the way to its targets within 15 minutes after a warning. If an enemy attack were to destroy SAC's ground control centers, retaliatory attacks would be directed from an airborne command plane. One of these planes is in the air at all times. SAC was organized in 1946, and has headquarters at Offutt Air Force Base, Nebr. See also OFFUTT AIR FORCE BASE; WESTOVER AIR FORCE BASE; NEBRASKA (picture: Underground Command Post). THOMAS S. POWER

STRATEGIC ARMS LIMITATION TALKS (SALT), a series of meetings between Russia and the United States, began in 1969. The two nations met in an attempt to limit the production of nuclear weapons.

President Lyndon B. Johnson proposed the talks in January, 1967, in an attempt to end the costly arms race between Russia and the United States. At that time, the Russians were trying to overtake the United States in producing offensive intercontinental ballistic missiles (ICBM's) and submarine-launched missiles. Later, they began building an antiballistic missile (ABM) system to defend Moscow.

The SALT talks started in November, 1969. By then, both nations had nearly equal ability to attack each other with nuclear missiles. The first round of meetings was completed in December, 1972. The meetings took place in Helsinki, Finland; Vienna, Austria; and Geneva, Switzerland. The second round of SALT meet-

ings began in March, 1973, in Geneva.

During a visit by President Richard M. Nixon to Moscow in 1972, the United States and Russia signed two major agreements resulting from the SALT talks. One was a treaty limiting each country's defensive missile system to two ABM sites with no more than 100 missiles at each site. The other pact limited production of certain offensive nuclear weapons for five years. Both agreements went into effect in 1972. In 1974, the two nations agreed on guidelines for another round of SALT negotiations restricting offensive nuclear weapons. GIL CARL ALROY

STRATEGIC SERVICES, OFFICE OF (OSS), was a secret intelligence agency of the United States government during World War II. William J. Donovan headed the office under the direction of the Joint Chiefs of Staff. It was organized in 1942 to gather and analyze information, and conduct psychological and guerrilla warfare. Experts in many fields performed heroic acts, often behind enemy lines.

The OSS was dissolved after the war ended in 1945. Its functions were divided between the Department of State and the War Department. In 1947, the Central Intelligence Agency (CIA) was formed to unify all government intelligence agencies (see CENTRAL INTELLIGENCE AGENCY). MAURICE MATLOFF

STRATFORD FESTIVAL. See CANADA (picture: Theater); CONNECTICUT (Annual Events; color picture: Shakespeare Festival Theatre); SHAKESPEARE, WILLIAM (Modern Performances); STRATFORD-UPON-AVON; ONTARIO (Annual Events).

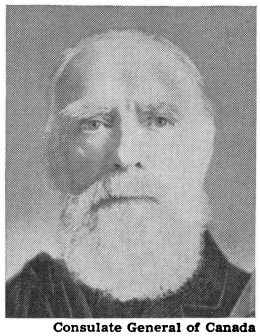
STRATFORD-UPON-AVON (pop. 19,760) is a quiet English market town that has become famous as the birthplace of William Shakespeare. It is one of the oldest towns in England. It lies in the green valley of the River Avon, 8 miles (13 kilometers) southwest of Warwick (see GREAT BRITAIN [political map]). High-peaked Old English style houses line the narrow streets.

The house where Shakespeare was born has been kept as a memorial. It is always open to visitors. At Shottery, 1 mile (1.6 kilometers) west of Stratford, is the thatched-roof cottage that was the home of Anne Hathaway, Shakespeare's wife. The Guild Hall and Grammar School are kept as they were in Shakespeare's day. Visitors also go to nearby Wilmcote to see the cottage of Mary Arden, Shakespeare's mother. Another tourist spot is the chancel of Holy Trinity Church, where Shakespeare and his wife are buried.

In 1879, a Shakespeare Memorial was completed on the riverbank above the church. It includes a theater, a museum, and a library that contains valuable books and manuscripts having to do with Shakespeare and his life. The theater burned in 1926, but people immediately donated funds to rebuild it. The new theater was designed by Elisabeth Scott and it opened in 1932.

Each summer, a Shakespeare festival is held in Stratford. England's leading actors perform many of Shakespeare's plays. At first, the festival lasted only a week. But it now lasts from April to November. American citizens gave funds to build a fountain and a clock tower in Stratford. FREDERICK G. MARCHAM

See also SHAKESPEARE, WILLIAM (pictures).



Consulate General of Canada

Baron of Strathcona

STRATHCONA AND MOUNT ROYAL, BARON OF (1820-1914), DONALD ALEXANDER SMITH, was a Canadian fur trader, railroad builder, financier, statesman, and philanthropist. He was closely associated with the Hudson's Bay Company from 1838 until his death, and became a governor of the company in 1889. He went to Labrador when he was 18 and became a fur trader. Afterwards, he moved to Canada and became interested in the development of the Northwest Territories.

When Manitoba became a province, Smith was elected to the Manitoba Assembly. The next year he was appointed commissioner for the Northwest Territories and was also elected to the Dominion House of Commons, serving from 1871 to 1880 and from 1887 to 1896.

Smith was the chief promoter of the Canadian Pacific Railway. He served as president of the Bank of Montreal and as chancellor of McGill University. From 1896 to 1906, he acted as Canadian High Commissioner in London. Smith was a man of strong personality, vision, and great charm. Many educational and charitable institutions took advantage of his generosity. He was born in Forres, in what is now Grampian Region, Scotland. JEAN BRUCHÉSI

STRATIFIED ROCK consists of layers, or *strata*. Each individual layer is called a *stratum*. Most sedimentary rocks, such as shale, sandstone, conglomerate, and limestone, are stratified. See ROCK (Sedimentary Rock).

Originally all strata were more or less horizontal. However, folding of the earth's crust in many places has thrown the rocks out of their former position. The angle at which these layers incline to the horizontal plane is called the *dip*. The dip may range from 0 to 90 degrees (vertical). Sedimentary rocks are stratified on land because rivers and wind spread them in layers. They are stratified on lake and ocean bottoms by currents of the water. A. J. EARDLEY

STRATIGRAPHY. See ARCHAEOLOGY (Relative Chronology).

STRATOSPHERE is a layer of the earth's atmosphere. It lies between the *troposphere*, the layer nearest the earth, and the *mesosphere*. In the polar regions, the stratosphere begins about 6 miles (10 kilometers) above the earth. Near the equator, it starts about 10 miles (16 kilometers) above the earth. It extends upward to about 30 miles (48 kilometers).

The air in the stratosphere is spread out in horizontal layers. The word *stratosphere* comes from the Latin word *stratus*, meaning *spread out*. There is almost no *convection* (rising of warm air) in the stratosphere, and so very little moisture enters from the troposphere. As a result, clouds rarely form in the stratosphere. But much air from the stratosphere is pulled into the troposphere by low-pressure storm systems there.

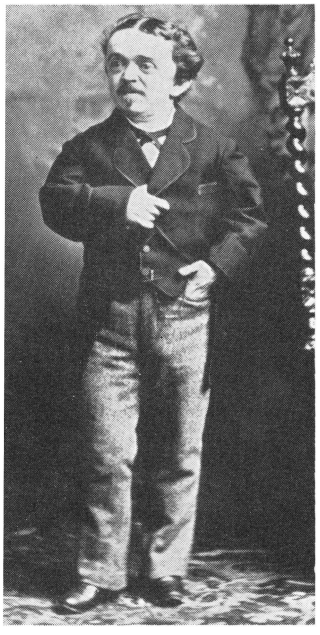
The stratosphere is warmer at its top than at its base. The lower 15 miles (24 kilometers) of the stratosphere have a temperature of about −67° F. (−56° C).

The temperature rapidly increases to about 28° F. (−3° C) at the *stratopause*, the upper layer of the stratosphere. The higher temperatures in the stratopause result from the presence of ozone gas there. Ozone absorbs ultraviolet rays from the sun. FRANK SECHRIST

See also AIR; TROPOSPHERE; MESOSPHERE; THERMOSPHERE; IONOSPHERE.

STRATTON, CHARLES SHERWOOD (1838-1883), was an American midget who became best known by his circus name, General Tom Thumb. Stratton was a dwarf (see DWARF). His small, doll-like body was perfectly formed. As a youth, Stratton was only 25 inches (64 centimeters) tall and weighed 15 pounds (6.8 kilograms). He was so bright that at the age of six he was exhibited by Phineas T. Barnum as though he were a full-grown man.

Charles S. Stratton became internationally famous by the name, General Tom Thumb. Brown Bros.



Later, Stratton grew to be 40 inches (100 centimeters) tall and weighed 70 pounds (32 kilograms).

Stratton was born in Bridgeport, Conn., to parents of normal height. Barnum persuaded Stratton's parents to let the boy join the museum in New York City in 1842.

Barnum took him to Europe in 1844, where he entertained royalty and caused a sensation. In 1863, Stratton married Lavinia Warren (1841-1919), another one of Barnum's midgets. F. B. KELLEY

STRATUM. See STRATIFIED ROCK.

STRATUS is a kind of cloud. See CLOUD (Kinds of Clouds; picture).

STRAUS, OSCAR (1870-1954), was a Viennese composer of operettas, of which *The Chocolate Soldier* and *The Waltz Dream* are the best known. Straus was not related to the Viennese "waltz kings," Johann Strauss and his sons. It was mainly through the many operettas that he wrote that Straus gained his fame and great fortune.

Straus studied composition with Max Bruch in Berlin. He played the piano and composed songs and sketches for Baron Ernst von Wolzogen's Überbrettl cabaret theater, which brought him his first success. In 1929 and 1931, he wrote motion-picture scores in Hollywood. When Adolf Hitler came to power in 1933, Straus left Berlin for Austria. He fled to Paris and then to the United States. Straus was born in Vienna. HALSEY STEVENS

STRAUSS, *shtrous*, was the name of an Austrian family of composers, a father and three sons. They became famous for their waltzes and operettas. All of them were born and lived in Vienna, then considered one of Europe's gayest and most romantic capitals. The Strausses wrote music that captured this "spirit of Vienna."

The Strausses began composing after a musical form called the *Walzer* had developed into a ballroom dance in $\frac{3}{4}$ time. The four men—particularly Johann Strauss, Jr.—were noted for the waltzes they composed for dancing. In addition, no other composers have rivaled them in the quality of orchestral waltzes intended for concert performance. See WALTZ.

Johann Strauss, Sr. (1804-1849), was the son of a dance- and beer-hall operator. After studying music and becoming a performing violinist and conductor, he began composing waltzes in 1825. He organized his first orchestra in 1826 and toured successfully. In 1845, Strauss was appointed conductor for the Vienna court balls. His many compositions greatly improved the status of dance music. He wrote about 250 pieces, including waltzes, polkas, galops, and marches. He is best known for the "Radetzsky March."

Johann Strauss, Jr. (1825-1899), became known as the "Waltz King." His most famous work was "On the Beautiful Blue Danube." He was the most talented and best-known member of the family.

Strauss became a musician against his father's wishes. In 1844, he formed an orchestra that he combined with his father's orchestra in 1849. After gaining international fame as both a conductor and composer, he turned the orchestra over to his brothers in 1862. Following visits to England, France, and Italy, he conducted concerts in Boston and New York City in 1872.

Strauss was a great success as a composer of operettas, especially *Die Fledermaus* (*The Bat*, 1874), *A Night in Venice* (1883), and *The Gypsy Baron* (1885). Of his nearly 500 compositions, almost all the most popular ones are concert waltzes that show his gift as a writer of melodies and his brilliance as an orchestrator. Strauss's waltzes include the "Emperor Waltz," "Artist's Life," "Tales from the Vienna Woods," "Vienna Blood," and "Wine, Women, and Song."

Joseph Strauss (1827-1870) was trained as an architect but studied music secretly. He was also a poet, painter, and inventor. He became famous as a conductor of the Strauss family orchestra and composed nearly 300 pieces.

Eduard Strauss (1835-1916) conducted his own orchestra when he was 27. In 1870, he succeeded his brother Johann as director of the Vienna court balls. Strauss wrote many compositions, but he had neither the genius of his father and brother Johann, nor the talent of his brother Joseph. Eduard's son, Johann Strauss III (1866-1939), became a successful conductor of light entertainment music. HERBERT WEINSTOCK

STRAUSS, FRANZ JOSEF (1915-), is a West German politician. He served as finance minister of West Germany from 1966 to 1969. As minister of defense from 1956 to 1962, he had an important role in building a modern defense force for West Germany. Strauss served as minister for special tasks from 1953 to 1955, and as minister for atomic affairs from 1955 to 1956.

Strauss was born in Munich and attended the university there. During World War II, he rose to the rank of lieutenant in the artillery. He was taken prisoner near the end of the war. After the war, Strauss helped organize the Christian Social Union political party, the Bavarian branch of the Christian Democratic Union. He has served in the Bundestag, a house of Parliament, since 1949.

STRAUSS, RICHARD

STRAUSS, *shtrous,* **RICHARD** (1864-1949), was a German composer. He is best known for a series of operas he composed to *librettos* (words) by the Austrian poet Hugo von Hofmannsthal. Strauss also became famous as a composer of songs and instrumental works and as a conductor.

Ewing Galloway

Richard Strauss

Strauss was born in Munich. His first important works for orchestra were tone poems based on narratives from poems or stories. They include, with dates of composition, *Don Juan* (1889), *Death and Transfiguration* (1889), *Till Eulenspiegel's Merry Pranks* (1895), *Thus Spake Zarathustra* (1896), *Don Quixote* (1898), and *A Hero's Life* (1898). Strauss also composed most of his almost 150 songs during this period. The best of his songs rank among the finest ever composed.

Strauss's first operas, *Guntram* (1893, revised 1940) and *Feuersnot* (1901), were unsuccessful. But they reflected the influence of the operas of Richard Wagner and had many of the qualities of Strauss's later operas. Like Wagner, Strauss used a stream of expressive and often complex music throughout each act. *Salome* (1905), Strauss's third opera, was his first success. It outraged many listeners because of its harsh, *dissonant* (unharmonious) passages. Many listeners feel that these passages characterize the unbalanced mind of the main character.

Strauss met Hofmannsthal soon after the première of *Salome*. Their first collaboration, *Electra* (1908), was an adaptation of the tragedy by the Greek playwright Sophocles. Strauss carried the dissonant style of *Salome* even further in *Electra*—and created greater controversy. In *Der Rosenkavalier* (1910), Strauss and Hofmannsthal tried to recreate the vanished aristocratic world of Vienna in the 1700's. This work is still Strauss's most popular opera.

Strauss wrote the most elaborate score of his career in *The Woman Without a Shadow* (1917), his next collaboration with Hofmannsthal. Many critics consider this opera Strauss's greatest achievement in musical drama. The work is highly symbolic, with both mortal and supernatural elements. Other works by Strauss and Hofmannsthal include *Ariadne auf Naxos* (final version, 1916), *The Egyptian Helen* (1927, revised 1933), and *Arabella* (first performed in 1933, after Hofmannsthal's death). Strauss's score for *Arabella* contains some of his most delicate and beautiful orchestral writing.

Strauss was one of the finest conductors of his day. He particularly excelled in interpreting the works of his two favorite composers, Wagner and Wolfgang Amadeus Mozart. Strauss held two important conducting positions—conductor of the Berlin Royal Opera from 1898 to 1918 and co-director of the Vienna State Opera from 1919 to 1924.

Strauss wrote five operas after Hofmannsthal's death in 1929. They include *The Silent Woman* (1935) and *Capriccio* (1941). During his last years, Strauss concentrated on a series of small-scale instrumental and vocal pieces. The best-known of these are *Metamorphoses* (1945) and *Four Last Songs* (1948). ROBERT BAILEY

See also HOFMANNSTHAL, HUGO VON.

STRAVINSKY, *struh VIHN skih,* **IGOR FYODOROVICH** (1882-1971), was a Russian-born composer. He and Arnold Schönberg are often considered the two most important composers of the 1900's.

Schaal, Pix

Igor Stravinsky

Stravinsky was born near St. Petersburg (now Leningrad). He studied composition under the Russian composer Nicholas Rimsky-Korsakov in 1907 and 1908. In 1914, Stravinsky settled in Switzerland. He moved to Paris in 1920 and became a French citizen in 1934. In 1940, he settled in the United States, where he became a citizen in 1945.

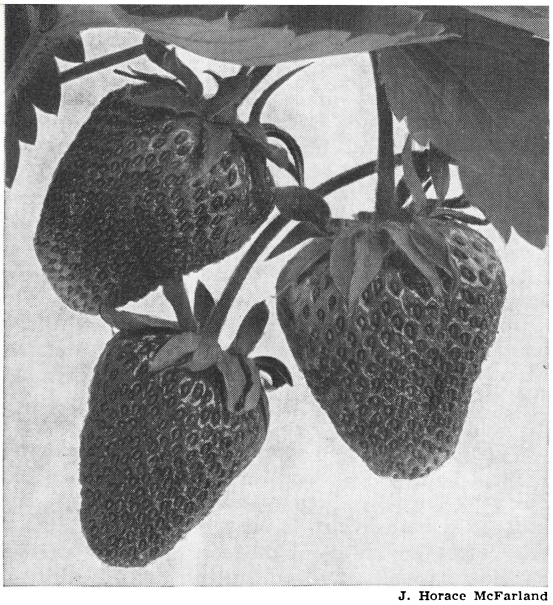
Stravinsky first gained international fame for his ballets. He collaborated with the Russian ballet manager Sergei Diaghilev in producing three ballets in Paris—*The Firebird* (1910), *Petrouchka* (1911), and *The Rite of Spring* (1913). At the first performance of *The Rite of Spring*, the ballet's violent and unconventional quality caused the audience to riot. These ballets and a number of others, including *The Wedding* (1923), are based on Russian folklore. Stravinsky's narrated ballet, *The Soldier's Tale* (1918), is also based on Russian folklore. But, unlike his earlier ballets, it is composed in an international cabaret style rather than a Russian style. It is one of several theatrical works in which Stravinsky used a dream as part of the subject matter.

During the early 1920's, Stravinsky began writing in a neoclassical style, using scales, chords, and tone color in a generally clear and traditional way. The period began with *Octet for Wind Instruments* (1923) and ended with *The Rake's Progress* (1951), Stravinsky's only long opera. Stravinsky often chose his models from music of the past. For example, he wrote *The Rake's Progress* in the style of the Austrian composer Wolfgang Amadeus Mozart. In the *Ebony Concerto* (1945), Stravinsky combined elements of the concerto grosso form of the 1600's with modern jazz band orchestration.

During his neoclassical period, Stravinsky wrote three major symphonies—*Symphony of Psalms* (1930), *Symphony in C* (1940), and *Symphony in Three Movements* (1945). He also explored the sonata and concerto forms in such works as *Piano Sonata* (1924) and *Concerto for Violin* (1931).

At first, Stravinsky strongly opposed the 12-tone style of composing developed by Schönberg. But starting in the early 1950's, Stravinsky began a series of works using a modified 12-tone technique. These works included *In Memoriam Dylan Thomas* (1954) for tenor and instruments, the choral *Canticum Sacrum* (1956), and the ballet *Agon* (1957). Stravinsky then composed the choral *Threni* (1958) and *Requiem Canticles* (1966) in a complete 12-tone style. JAMES SYKES

See also MUSIC (The 1900's); SCHÖNBERG, ARNOLD.



J. Horace McFarland

The Heart-Shaped Juicy Strawberry has a delicious flavor and aroma. Strawberries are often eaten as dessert.

STRAW consists of the dried stems of such grains as wheat, rye, oats, and barley. Straw has many different uses. Farmers use it as bedding for animals, and for soil improvement. Manufacturers use straw to make hats, baskets, saddles, bottle covers, paper, suitcases, and strawboard for mounting and binding. In the chemical laboratory, straw is used to produce carbon, phenol oil, pitch, and acetic acid.

Wheat straw makes the best hats. The stalks are pulled out of the ground, cut into short lengths, and laid in the sun. The sun bleaches the straw almost white. The leaves are then pulled off, leaving only the stem, which is bleached again with sulfur. The straw is sorted according to color and is ready for weaving into hats. In some countries, mechanical looms do the weaving. But in many parts of Europe, Japan, and China, the work is done by hand. Some of the best hand-braided straw comes from Tuscany, Italy, where Leghorn straw braids are made from a special kind of straw. Panama hats are not made from a straw, but from the leaf fiber of a tropical tree. Straw is different from hay, which is dried young grasses or other plants that are used as feed for domestic animals. RICHARD W. POHL

STRAWBERRY, a small plant belonging to the rose family, is grown for its tasty fruit. The strawberry plant grows close to the ground, and has a short woody stem. The leaves grow on the stem in groups of three. The strawberry has short roots and small white flowers that have a pleasant odor. The greenish white fruits turn to a rich red color when they ripen. These berries give off a pleasant fragrance and have a delicious taste. They are among the earliest fruits in the garden. The berries seem to be *strewn* (scattered) among the leaves of the plant. This may be why the plant was first called *strewberry*. Gradually, it came to be called *strawberry*.

The fruit of the strawberry differs from the true berry, such as the huckleberry. The strawberry does not have an outer skin around the seed. It has a fleshy, swollen fruit with dry yellow seeds on the outside. When the strawberry ripens, the petals of the flower fall off and all that remains is the *calyx*, a leafy substance shaped like a star. Not every strawberry flower produces fruit, however. Some flowers do not have stamens. These must be planted near plants that have stamens, so that their pollen can fertilize the seeds. This type of pollination is known as *cross-pollination*.

The strawberry plant does not reproduce by seeds. When the fruit is developing, the plant sends out slender growths called *runners*. These look like strings. They grow on the ground and send out roots in the soil. The roots produce new plants which grow and bear fruit. Sometimes these plants are taken from the soil and replanted to start a new plantation of strawberry plants.

The strawberry fruit is considered one of the most important small fruits grown in the Western Hemisphere. It grows both as a wild plant and as a cultivated plant. The strawberry was originally grown in northern Europe, but wild species also are found in Russia, Chile, and the United States. The first American species of strawberry was cultivated about 1835. Today, every state in the United States and every province in Canada grows the strawberry plant.

Strawberry plants can be planted in any garden soil. But the richer the soil, the larger the crop. The plant grows best in a cool, moist climate and does not do well in warm temperatures. The strawberry is planted in rows. Young plants are used for setting the rows. The rows are usually 3 feet (91 centimeters) apart and the plants are set 18 inches (46 centimeters) apart in the rows. The plants may be planted in the spring or fall, but if the temperature is too cold, fall planting requires a great deal of care. Some strawberries, called *everbearing*, produce berries throughout the summer and fall.

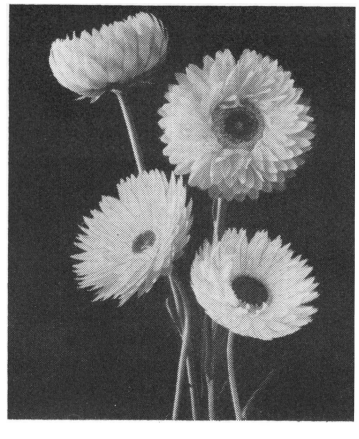
The strawberry fruit can be prepared in many tasty dishes. The fruit is a good source of vitamin C. Strawberries are exceptionally well adapted to quick freezing. The frozen berries, like the fresh ones, are used in ice cream, pastries, and jellies.

Scientific Classification. The strawberry belongs to the rose family, *Rosaceae*. Strawberries make up the genus *Fragaria*. Common American plants include genus *Fragaria*, species *F. virginiana* and *F. chiloensis*. LEE A. SOMERS

STRAWFLOWER is a tall annual herb with yellow, orange, red, or white flowers. People dry them and use them as winter bouquets. The strawflower originated in Australia, and is now raised in gardens in Europe and America. The plant grows 3 feet (91 centimeters) tall and produces flowers from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches (3.8 to 6.4 centimeters) wide. It grows from seeds.

The Strawflower has yellow, orange, red, or white flowers.

J. Horace McFarland



Scientific Classification. The strawflower belongs to the composite family, *Compositae*. It is genus *Helichrysum*, species *H. bracteatum*. ALFRED C. HOTTES

STREAM. See RIVER.

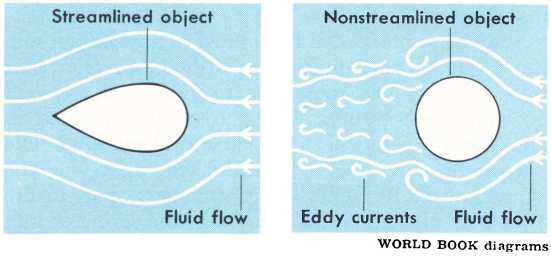
STREAM OF CONSCIOUSNESS. See AMERICAN LITERATURE (Regionalists).

STREAMLINING

STREAMLINING is the shaping of a body so that it meets the smallest amount of resistance as it moves through a *fluid* (liquid or gas). The best streamlined shape for a body depends on whether it is to travel slower or faster than sound through the fluid. For *subsonic* (slower than sound) travel, a body should be somewhat blunt and rounded in front, and then taper to a point at the tail. Submarines and subsonic airplanes have this shape. In nature, fish have this type of streamlining. For *supersonic* (faster than sound) travel, a body should have a sharply pointed front. Supersonic airplanes and rockets have this shape.

THE EFFECTS OF STREAMLINING

A streamlined object, *left*, offers the least resistance to a fluid flowing past it. A round object, *right*, causes eddy currents that increase its resistance to the flowing fluid.



WORLD BOOK diagrams

The resisting force acting on a body as it travels through a fluid is called *drag*. The amount of drag depends on how smoothly the fluid flows around the body. The path that any bit of fluid follows around the body is called a *streamline*. If a body is streamlined, the streamlines separate smoothly at the front, pass smoothly around the body, and meet again at the tail. But if the body is not streamlined, the fluid may swirl and twist violently as it passes around the body. These motions are called *eddy currents*. The fluid may separate from the surface of the body and cause a partial vacuum behind it. The amount of drag increases because of the lack of pressure behind the body to balance pressure in front.

The effects of streamlining can be measured in a *wind tunnel*. In the tunnel, air is blown past a body so the drag can be measured. Streamlines can be made visible by adding smoke to the air at several points. When a flat plate is tested in the tunnel, streamlines can be seen curving around the edges of the plate. The air behind it is disturbed, forming eddy currents and a partial vacuum. The drag on the plate is relatively large. The streamlines can be seen following the surface more smoothly on a properly streamlined body. No eddy currents are produced, and there is less drag.

In addition to a body's shape, three other factors affect the drag: (1) the density of the fluid, (2) the amount of the body's area that meets the fluid, and (3) the speed of the body through the fluid. The drag doubles if either the fluid's density or the area of the body meeting the fluid is doubled. Doubling the speed of the body multiplies the drag by four. WILLIAM L. HULL

See also AERODYNAMICS; WIND TUNNEL.

STREET is a road within a town or city. Streets lead out of the cities and towns, through the surrounding suburban areas, and connect with roads and highways (see ROADS AND HIGHWAYS). Streets serve the people who live and work in cities and towns. They also serve the people who come from farms and other nearby places for business and recreation. Some streets are used almost entirely by pedestrians. This is particularly true in some countries that have few automobiles.

Streets called *arterial* streets carry the most traffic and provide routes to the most important sections. Many of them are wider than other streets. Sometimes they are divided in the center to separate the traffic going in opposite directions. *Avenues* and *boulevards* are examples of important arterial streets. *Parkways* run through parks or parklike areas. Most are limited to passenger cars only. *Expressways* and *freeways* carry fast traffic. They are divided in the center, and crossings of other streets are always on different levels. To arrange for these crossings, dry-land bridges, called *grade separations*, are built. At the most important grade separations, ramps are built so that vehicles can get to and from the expressways and the other streets without crossing in front of each other.

There are about 613,000 miles (987,000 kilometers) of streets in the United States. This is about 16 per cent of the nation's total streets, roads, and highways. New York City has 6,000 miles (9,700 kilometers) of streets—more than any other city in the United States.

How Streets Are Built

Planning. Good street planning begins with a general plan for a beautiful and useful city. This plan shows the areas for businesses, factories, stores, parks, public buildings, and homes. It also includes a layout of streets serving the city and the surrounding suburban communities. Counts of traffic and other studies show where traffic comes from, where it goes, and in what volume. With this information, engineers plan important streets that will take people where they want to go with the least interference. The large number of cross streets, and the need for public transportation, parking space, and sidewalks complicate street planning.

Traffic engineers try to make existing streets as useful as possible. As traffic increases, some streets carry more vehicles than they were first designed to handle. Engineers must then find ways to provide more street space for vehicles to use at faster speeds. Some streets can be widened by moving their edges closer to buildings. Dead-end streets can be connected with other streets, or one-way streets can be created. In larger cities, expressways or freeways may be built.

Cables and pipelines carrying electricity, telephone wires, gas, water, and sewage run under city streets. In large cities subways sometimes run underneath the streets (see SUBWAY).

Draining. Much of the rainfall in cities and towns cannot sink into the ground. So it runs onto the streets. Most streets have gutters along the sides which are lower than the street level. The water runs into the gutters and along them into openings called *catch basins*, connecting with underground sewers. Smaller towns and suburbs sometimes have shallow ditches instead of paved gutters. These ditches may be carried under driveways and cross streets by pipes called *culverts*.

STREETS NEED CONSTANT CARE

Asphalt Joints Between Concrete Slabs must be repaired regularly. The joints keep water, snow, and ice from seeping between the slabs and cracking them.

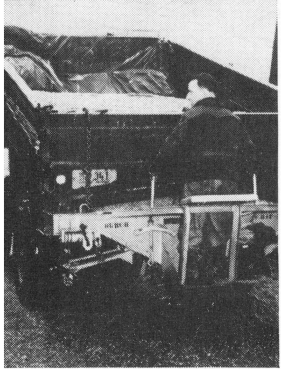
Replacing a Concrete Slab. When a single concrete slab wears out it is necessary to cut out the old piece and pour in new concrete.

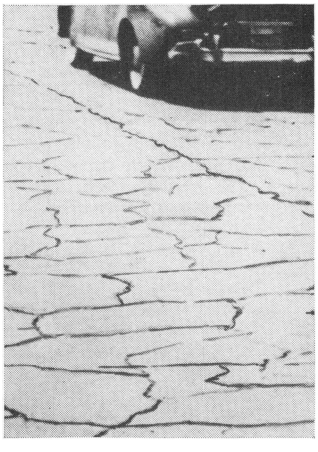
Resurfacing an Old Street with an asphalt mixture. Many old concrete, brick, and block streets are saved for further use in this way every year.

Fruehauf Trailer Co.; The Texas Co.; Bureau of Public Roads

MEN AND NATURE CAUSE DAMAGE TO STREETS

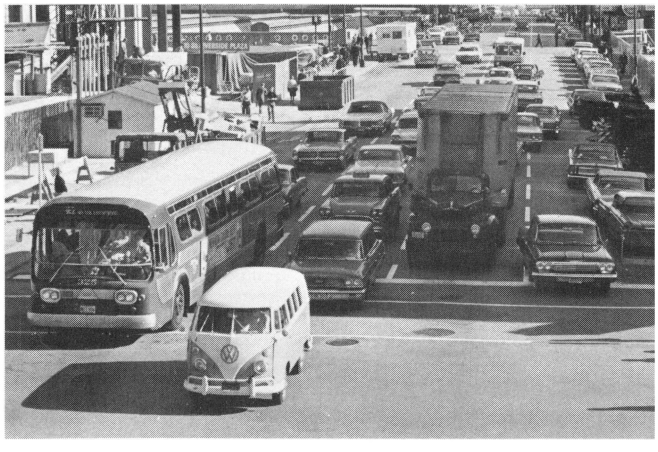
Salt and Other Chemicals, spread on streets to prevent skidding in icy weather, cause wear to pavement.





Extremes of Heat and Cold may cause pavement to crack so that the street must be resurfaced.

Martin J. Schmidt



Heavy Automobile, Bus, and Truck Traffic is a major cause of wear on streets. Only automobiles and light trucks are allowed on some busy streets, reducing wear on pavement.

Surfacing. Most city streets are paved with brick, bituminous materials, or concrete. Brick pavements usually are laid on sand spread over the ground or over a concrete foundation. *Bituminous* materials are made of asphalt or tar mixed with stone and sand. They are usually black in color. Concrete is made of cement, sand, gravel, or stone, and water. The pavement, as well as the foundation underneath, is of different thickness depending on the firmness of the ground and the type and volume of traffic expected. Some outlying streets are surfaced with gravel or stone, sometimes topped with a coating of oil, tar, or asphalt.

Intersections. Places where streets meet one another are called *intersections*. When the streets are on the same level, the intersections may be the scene of accidents and traffic jams. Many intersections have traffic signals to regulate the flow of traffic. Sometimes, circles or islands are built to help channel traffic into the correct lanes. These are used especially at wide intersections and where more than two streets meet. Expressways and freeways, with intersecting streets at different levels, have the safest kind of crossings.

Lighting. Good street lighting at night helps reduce crime and traffic accidents. Much of the light on streets comes from the headlights of vehicles, but most communities also have street lights. Many street lights have mercury vapor lamps, which are much brighter than the incandescent lamps used in homes. High-pressure sodium vapor lamps are also widely used for street lighting. These lamps produce a yellow-orange light that is brighter than the light of mercury vapor lamps.

How Streets Are Maintained

Repairing and Resurfacing. Weather and traffic gradually cause the street surface to wear out or become uneven. Most holes and breaks in the surface are filled with the same kind of material from which the streets were built. Cracks and joints in concrete are filled with bituminous materials. Black-top pavements may be sealed with a thin coating of bituminous material to waterproof the pavement and help preserve it.

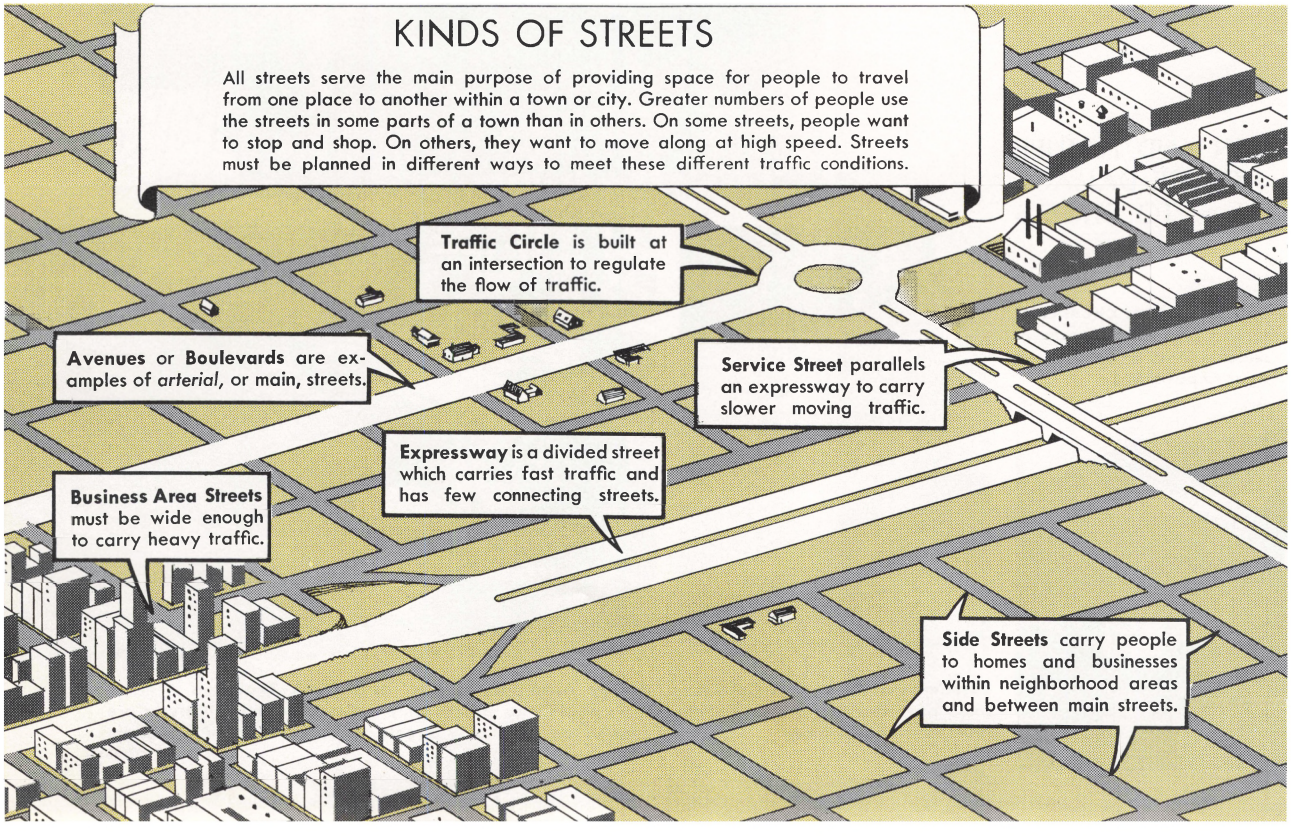
When most of a street surface wears out or becomes uneven, new material may be added over the entire surface. This is called *resurfacing*. It smooths rough pavements and saves the base for further use. Curbs, gutters, and sidewalks seldom can be raised, and it often is necessary to strip off and replace the old surface. Sometimes the foundation must be repaired also.

On streets which are covered with gravel or stone, the surface must be reshaped from time to time, especially after wet weather. This usually is done with a scraping machine called a *motor grader*. This work, along with the addition of new material at intervals, helps keep the surface smooth.

Clearing Ice and Snow. Rain or sleet may freeze on streets. Then, salt or other chemicals may be spread to melt the ice. Often, these chemicals are mixed with sand or cinders which provide better traction for tires.

In northern climates, snow frequently blocks streets and must be removed or pushed off to one side. This is done with motor graders or with plows fastened to the fronts of trucks. Often, special crews of men are hired to load the snow into trucks so it can be hauled away. The loading is done by hand shovels or by elevating loaders. Elevating loaders are a system of buckets rigged on an endless chain. These "eat" into a snowbank and dump the snow into the trucks. Rotary plows sometimes are used to clear snow. The rotary plows have a big screw on the front. This screw feeds the snow through a spout and into a truck or off to the side of the street.

Cleaning. Streets get dirty from trash, leaves, and cinders. Maintenance crews often use machines



equipped with large brushes to sweep the streets. Some of these machines are like big vacuum cleaners which suck up the dirt and dust. Every once in a while, streets may be flushed with water from trucks. This washes the dirt into the gutters and on into the sewers. Some machines have water, brushes, and vacuum all combined in one. In some places, men sweep the gutters with a brush and load the dirt into trucks or small pushcarts.

How Streets Are Paid For

Most streets are paid for largely from taxes paid by people who live in the cities and towns. A part of every property owner's taxes goes for construction and maintenance of streets. In addition, many of the local, or residential, streets are paid for by special taxes, called *assessments*, on the property served by the streets.

In recent years, cities and towns have received a greater share of the gasoline taxes and license fees collected by the state. The state legislature usually decides how much cities and towns are to be given from such funds. The money usually is divided according to population. Some cities also have their own special license fees and other taxes for street maintenance.

Some state highway departments build and maintain certain arterial streets that are extensions of the roads and highways leading into a city. The federal government also helps pay for some arterial streets. The state and city, or town, provide additional amounts.

Many cities borrow money so that street work can be done sooner than it could if they had to wait until the money were saved up from taxes. The borrowed money is repaid as taxes are collected.

MONEY SPENT FOR CITY STREETS IN THE UNITED STATES

Year	Total
1921	$ 346,000,000
1930	860,000,000
1940	611,000,000
1950	1,144,000,000
1960	3,160,000,000
1970	6,598,000,000
1973 (estimate)	7,735,000,000

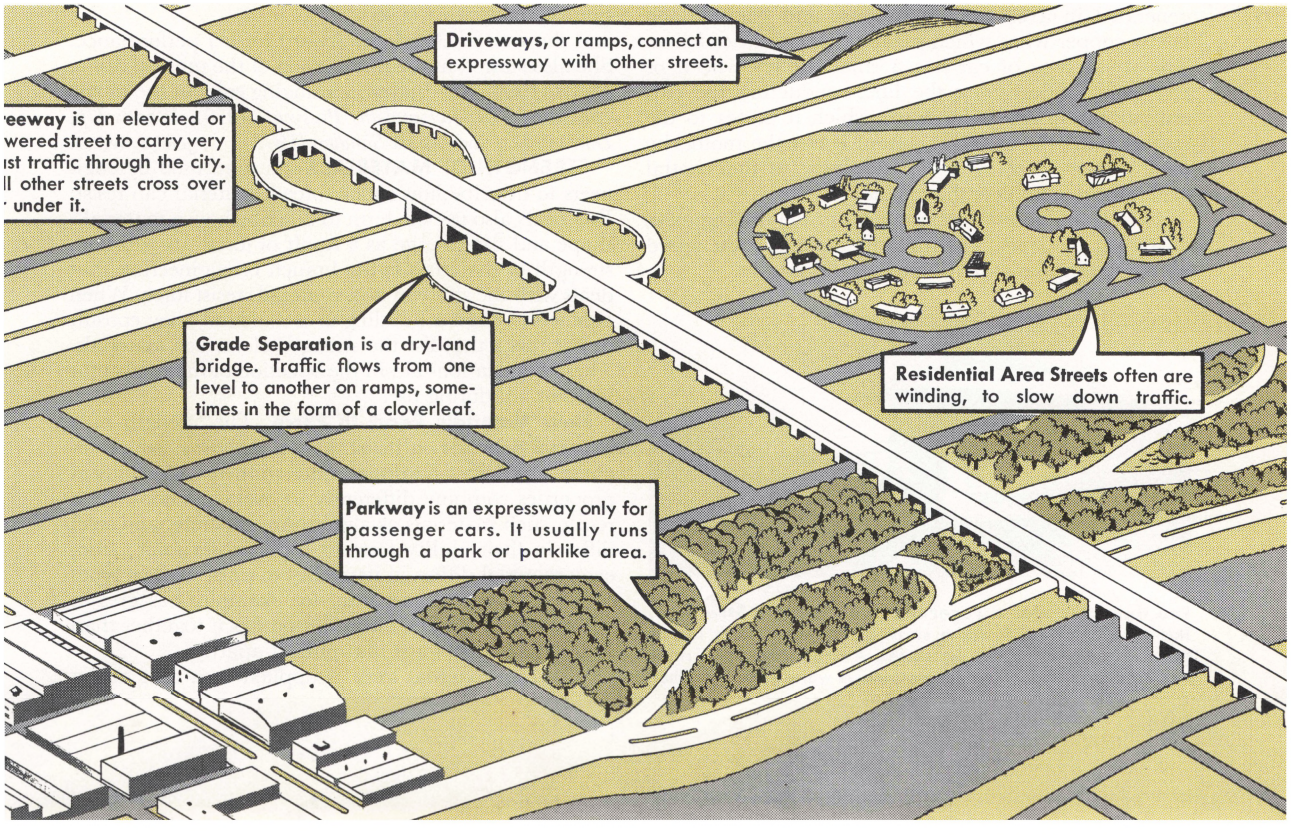
Source: Federal Highway Administration

History of Streets

Streets are as old as cities and towns. Greek, Roman, and other ancient cities had some paved streets and many unpaved streets. These streets often were very narrow and winding. Sometimes they were as steep as a flight of stairs. In the 1200's, the rapid growth of towns created a need for paving the main streets. A leader in the movement to pave streets in western Europe in the 1200's was King Philip Augustus of France. He had the street in Paris in front of his palace, the Louvre, paved with stones. Before this, the street was little more than an open sewer. He probably had it paved to overcome the bad odor and to obtain a smooth surface for travel. In England, the first paved street was laid in London in 1417. The laying-out of city streets at right angles to each other, in a gridiron pattern, developed from the feudal town arrangement of the Middle Ages.

In some early American cities, many of the streets may have followed cowpaths of the original farming villages. The streets in some cities were laid out in advance. One of these cities is Washington, D.C., the nation's capital. There the Capitol is in the center of the city, with avenues leading out like spokes in a wheel. Other streets form a checkerboard or grid pattern. Circles were built at many points where avenues intersect streets. Supposedly, these circles were planned as places of defense in the event of an enemy attack.

Many early streets in America were surfaced with



round, uneven cobblestones and wood blocks. The first successful brick pavement was laid in Charleston, W. Va., in 1873. Stone blocks somewhat thicker and wider than bricks were another early paving material for streets. These still may be seen in use, especially between streetcar tracks. A bituminous pavement was patented in 1834 but was not used generally until many years later. The first concrete pavement was laid in Bellefontaine, Ohio, in 1893.

Street widths vary from narrow ones like those in downtown Boston and New York City to broad ones like those in Washington, D.C., and Salt Lake City. In recent years, more and more cities have found it necessary to widen old streets and build new expressways to handle the increasing traffic. HENRY A. BARNES

See also ROADS AND HIGHWAYS with its list of Related Articles.

STREETCAR. The first streetcars were pulled by horses. They were called *horsecars*. Later, a *cable car* was invented. It was pulled by a cable, which was drawn by steam power. The cable ran through a small trench in the surface of the ground. The streetcar attached itself to the cable by means of a gripping device. Therefore it was also called a "grip" car.

In the early 1800's, inventors began trying to use electric power. But for many years the cost of generating electricity was too great to be practical. The invention of the electric generator solved this problem, and by the 1880's a number of electric cars were exhibited. The first commercial electric railway was operated in Lichterfelde, Germany, in 1881. In 1888, Frank J. Sprague opened the first successful electric "street railway" in the United States, in Richmond, Va. Electric cars immediately began to replace cable cars and horsecars.

The modern streetcar gets its power from an overhead line by means of a long trolley pole. The current is generated in a central powerhouse and passes along heavy copper wires which make up the overhead line. The usual type of car has a small trolley wheel, or *shoe*, which rides along the line, conducting the current to the trolley pole, down which it passes to the motors under the car. The current leaves the motors by means of the tracks, and passes back to the central generator to complete the circuit.

The electric motors are attached to the driving axles of the car by gears. The motorman controls the speed by regulating the current with a control lever.

Chicago Transit Authority

The Horsecar Was a Forerunner of Today's Streetcar. The horsecar of 1878 was a swaying, noisy car which ran on two rails and was pulled by horses. A small stove, and straw scattered on the floor, kept the passengers warm in cold weather.

Each car has seats for 50 or more people. Straps hang from the ceiling in the front and rear aisles for people who are unable to find a seat.

The streetcar was important in the growth of cities. For years, it was one of the chief means of transportation in such places as Chicago and also in the smaller cities and in towns. The streetcar also was used for transportation between cities and towns in some areas before the automobile came into wide use. Only San Francisco, where there are many steep hills, continues to use the cable car.

The trolley bus, introduced in 1913, replaced the streetcar in some cities. It has a bus body and gets its power from an overhead trolley. The trolley bus does not use a track.

By the late 1930's, the streetcar became less important. But some cities continued to use them. Faster, quieter models replaced old cars. FRANKLIN M. RECK

See also CABLE CAR; ELECTRIC RAILROAD.

STREISAND, BARBRA (1942-), is an American singer and actress. She became famous for her dramatic interpretation of popular songs. She also gained praise as a comedienne both on the stage and in motion pictures.

Wide World

Barbra Streisand

Barbra Streisand was born in New York City. Her career began in 1961 when she entered a talent contest in a bar there. She won $50 and a nightclub engagement. She made her first Broadway appearance in the musical *I Can Get It for You Wholesale* (1962) and became a star in the musical *Funny Girl* (1964). Her motion-picture debut came in the film adaptation of *Funny Girl* (1968), and she won an Academy Award for her performance. She also starred in the film version of the musical *Hello, Dolly!* (1969). She played nonsinging roles in the movie comedies *The Owl and the Pussycat* (1970), *What's Up, Doc?* (1972), and *Up the Sandbox* (1972). JOHN S. WILSON

STRENGTH OF MATERIALS is a term used by engineers to describe how much force a material can resist. Engineers also use the term to describe how a material's shape and size change as a result of force. In addition, strength of materials is the branch of engineering that deals with the study of how materials resist force. When engineers design a building or a machine, they consult publications that list the strength of various materials. These publications aid in the selection of materials that will not fail during use.

How Materials React to Force. The strength of a material depends on its *mechanical properties*, which include elasticity, hardness, and stiffness. Mechanical properties combine differently in every material. As a result, such materials as aluminum, concrete, and steel differ in their ability to resist a particular force. Also, each material differs in its ability to resist various types of force. A bar of cast iron, for example, has greater ability to withstand a force that pushes it together than it does to resist a force that pulls it apart.

When an external force is applied to a material, a

force inside the material resists the external force. This internal resistance of a material to such a force is called *stress*. If a material cannot resist an external force, the material changes in shape and size. When a weight is put on the end of a rope, for example, the rope stretches. The actual change in a material—in the above case, the stretching of the rope—is called *strain*. The greater the amount of stress in a material, the greater the amount of strain that will occur.

Materials undergo three types of stress: *tensile stress*, *compressive stress*, and *shearing stress*. Tensile stress causes a material to stretch, as with the rope. Compressive stress causes a material to push together. The pillars that support a building undergo compressive stress because the weight of the structure pushes down on them. Shearing stress causes a material to separate into layers by a sliding action. Such an action resembles that of the cards in a deck, which slide apart when they are tilted so the edges are at an angle.

The stresses in a material may combine to resist force. Combined stresses cause *flexure* (bending) and *torsion* (twisting). For example, stresses unite in a springboard when a person stands on it. The person's weight causes tensile stress in the top section of the board, and the fibers there stretch. At the same time, the weight of the individual causes compressive stress in the bottom section of the board. As a result, the fibers there push closer together. This combination of stresses makes the board bend.

How Strength Is Determined. Technicians measure the strength of a material by using special machines that apply force to a sample of the material. First, they determine the material's *elastic limit*, the amount of force it can resist without changing permanently. If the applied force is lower than the material's elastic limit, the material will return to its original shape and size after the force is removed. But if the force exceeds the elastic limit, the material will change permanently.

Technicians also measure the *ultimate strength* of a material—that is, the maximum force it can resist without breaking. Engineers consider ultimate strength in terms of the number of pounds of force per square inch (kilograms of force per square centimeter) that a material can withstand. For example, a bar of cast iron can withstand about 30,000 pounds per square inch (2,100 kilograms per square centimeter) of a pulling force without breaking. Laboratory tests for strength are not exact. The results are affected by such factors as a material's age, composition, and moisture.

In constructing a building or a machine, engineers use a material strong enough to resist a heavier load than the one expected. This policy helps ensure that the material will not fail during actual use.

Development of New Materials. During the late 1960's, scientists began the extensive development of *composite materials*. Such a material contains two or more materials. Many composite materials contain a large amount of one substance combined with fibers, flakes, or layers of another. Composite materials have greater strength than many single materials. For example, glass fibers combined with plastics form a material called *fiberglass reinforced plastics*. This material has greater strength than either the glass or the plastics alone. Manufacturers use fiberglass reinforced plastics to make such products as boat hulls, building panels, and truck parts.

During the early 1970's, scientists increased the development of composite materials that contain fibers. Two of the strongest fibers consist of *boron*, a chemical element, and *graphite*, a form of carbon. Boron fibers and graphite fibers can withstand intense force and high temperatures. These fibers are undergoing research for use in aircraft and rocket parts.

Many materials gain greater strength when produced in the form of *whiskers*, which are extremely thin, tiny crystals of a substance. Whiskers are stronger than fibers because they have fewer flaws than do fibers. One of the strongest types of whiskers is made of sapphire.

R. J. HARKER

See also DUCTILITY; ELASTICITY; FATIGUE, METAL.

STREP THROAT is an infectious disease that chiefly affects children from 5 to 15 years old. The disease is also called *septic sore throat* and *streptococcal sore throat*. Certain bacteria of a type called *group A streptococcus* cause strep throat (see STREPTOCOCCUS). The bacteria in this group also cause scarlet fever.

Symptoms of strep throat include fever, sore throat, aching muscles, and headache. If a patient has any of these symptoms, a doctor may use pus taken from the person's throat to make a culture (see CULTURE). If the person does have strep throat, strep bacteria will grow in the culture and be visible under a microscope.

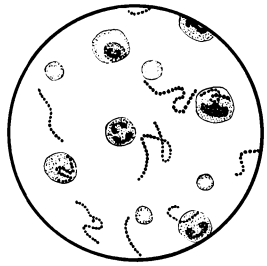
Doctors use such drugs as penicillin and erythromycin to treat strep throat. Prompt treatment can keep the infection from spreading to the ears and sinuses. Most people who receive the correct treatment recover from strep throat with no aftereffects. In rare cases, patients later develop *glomerulonephritis*, a kidney disease; or rheumatic fever (see NEPHRITIS; RHEUMATIC FEVER). At least 10 days of drug treatment usually prevents these complications.

A person can get strep throat by direct contact with someone who has the disease or with a healthy carrier (see DISEASE [How Diseases Spread]). In rare cases, strep throat bacteria may be spread in contaminated food.

STUART LEVIN

STREPSIPTERA is an order of insects that are parasites of other insects. They are sometimes called *stylops* or *twisted-winged insects*. The males live only one or two days. They have large, fan-shaped hind wings. The front wings look like small clubs. The females have no eyes, wings, or legs. They live in the bodies of bees, wasps, crickets, and other insects.

STREPTOCOCCUS, *STREP toh KAHK us* (plural, streptococci, *STREP toh KAHK sy*), is a type of bacterium that causes several serious diseases. Bacteria are sometimes considered



American Medical Association

Streptococcus Germs look like black, beadlike chains.

the lowest forms of plants. The streptococci are shaped like spheres and live together, forming chains. They infect the body by growing in it and producing poisons, called *toxins*. Sometimes a colony grows in one place, but some types of streptococci may spread through the body. The type *Streptococcus pyogenes* include the bacteria of septicemia (blood poisoning), impetigo, erysipelas, puerperal fever, septic sore throat, and scarlet fever. *Streptococcus pneumoniae*, called *pneumococcus*, is the cause of one kind of pneumonia. GEORGE L. BUSH

See also BACTERIA; DISEASE (graph: Main Contagious Diseases in the U.S.); TOXIN.

STREPTOMYCIN, *STREHP tuh MY sihn*, is a drug that fights the bacteria that cause many diseases. It is said to be successful against infections that resist sulfa drugs and penicillin. It is the first drug that has found extensive application in the treatment of tuberculosis. See PENICILLIN; SULFA DRUGS.

Streptomycin is produced by a tiny plant that grows in the soil, a microorganism named *Streptomyces griseus*. In 1939, Selman A. Waksman of Rutgers University began to test microscopic growths to find a substance that could be used against disease germs. The best substance he found was formed by a microbe belonging to the group of actinomycetes, of the genus *Streptomyces*. It was named *streptomycin*.

Streptomycin is given off into a broth in which the microorganisms are grown. The impure drug is separated from the broth first as a solution, then as a solid. Then the drug is purified to small crystals of its salts, which form a white powder.

Chemically, streptomycin is an organic base, and forms several salts. The solid drug can be stored in a refrigerator for six months. Solutions keep their power for a considerable time, even when heated.

Streptomycin can be injected into the muscles, under the skin, or it can be taken by mouth or sprayed into the lungs. It is reported to have checked types of streptococcus and staphylococcus, Gram-negative and Gram-positive bacteria, and mycobacteria.

Streptomycin acts by interfering with the growth of the microbes. This effect is *bacteriostatic*. It kills bacteria, a *bactericidal* action. Streptomycin is effective in the treatment of tuberculosis, infections of the urinary passages, typhoid fever, pneumonia, dysentery, undulant fever, and such wound infections as gas gangrene. It may supplement the action of other drugs. SELMAN A. WAKSMAN

See also ANTIBIOTIC (Kinds of Antibiotics); WAKSMAN, SELMAN ABRAHAM.

STRESEMANN, *SHTRAY zuh mahn*, **GUSTAV** (1878-1929), a German statesman, was one of the authors of the Locarno Pact (see LOCARNO CONFERENCE). Elected to the Reichstag (the lower house of the German parliament) in 1906, he became the leader of the National Liberal Party and, later, of the German People's Party. In 1923, he became chancellor and foreign minister, and he secured Germany's admission to the League of Nations in 1926. Stresemann shared the 1926 Nobel peace prize with Aristide Briand. Stresemann was born in Berlin. GABRIEL A. ALMOND

STRESS. See STRENGTH OF MATERIALS; ELASTICITY; ANNEALING.

STRIAE. See GLACIER (Erosion).

STRIKE, in business and industry, is a stopping of work by a group of employees. All or some of a company's employees may be involved. A strike is designed to interrupt the normal flow of goods or services that a company produces or handles. The workers use the strike as their main bargaining weapon. They hope that a strike or the threat of a strike will persuade the company to agree to their demands for higher wages, improved working conditions, or other benefits.

The term *strike* also refers to any stoppage of normal operations or activities to protest an action or condition. During the 1950's and 1960's, some civil rights workers in the United States staged sit-down strikes. They sat down in public places and refused to move as a form of protest against racial injustice. Some prison inmates have gone on hunger strikes and refused to eat until officials considered their grievances. In the late 1960's and early 1970's, college students in many countries struck for various kinds of changes.

However, strikes are most closely associated with work stoppages in business and industry. This article chiefly discusses such labor strikes.

Functions of Strikes. A strike is a sign of dissatisfaction among a large or small number of workers in a plant or industry. By striking, workers take action to express a grievance or to enforce a demand. In the 1800's and early 1900's, many strikes in the United States resulted from workers' efforts to get employers to recognize unions as their bargaining agents. Today, most strikes involve disputes over wages, hours, and other conditions of employment.

Strikes are an important part of the *collective bargaining* process between workers and employers. In this process, representatives of both parties meet to establish conditions of employment that will be jointly acceptable. There are more than 150,000 collective bargaining contracts in the United States. Most of these agreements are reached—and renegotiated periodically—without strikes. During the 1960's, strikes accounted for a work loss of only about four hours a year per U.S. worker.

Strikes occur occasionally in any society that encourages free collective bargaining. No matter how reasonable the two sides may be, some disagreements will arise between labor and management. During the bargaining process, a strike or the threat of a strike increases the cost of being unreasonable. It encourages each side to seriously consider the other's arguments and demands.

Kinds of Strikes. There are various kinds of strikes. An *authorized strike* is one agreed upon by union officials or a majority of the union members. A *wildcat strike* is a strike called by a group of workers without official union support. Most strikes are *walkouts*, in which the workers leave their jobs. A *sit-down strike* is a strike in which people stop working but do not leave their place of employment. A *sympathy strike* is called by one union to support another union that is on strike. A *jurisdictional strike* may result when rival unions claim the right to work on the same job. A *secondary strike* takes place when workers call a work stoppage in an attempt to force their employer to stop doing business with

Abraham J. Siegel, the contributor of this article, is Professor and Associate Dean of the Sloan School of Management at the Massachusetts Institute of Technology.

another employer who is involved in a labor dispute.

Generally, nonpublic employees have the right to strike. Similarly, private employers may close their plants in order to keep employees from working. Such action is called a *lockout*. Almost all collective bargaining agreements prohibit strikes and lockouts during the term of a contract. In the United States, federal laws also prohibit or limit certain kinds of strikes. For example, the Taft-Hartley Act bans jurisdictional strikes, secondary strikes, and sympathy strikes. The Taft-Hartley Act and the Railway Labor Act include provisions to delay strikes that might create a national emergency.

Many public employees may legally engage in collective bargaining. But strikes by public employees are illegal. Many federal, state, and local laws provide severe penalties for striking public employees. The ban on strikes by public employees is a source of friction in education, the postal system, and many other areas of government operations.

Strike Tactics in the United States and other industrial countries have been relatively peaceful for many years. But open warfare, loss of life, and destruction of property were common in the 1800's and early 1900's.

Union members usually follow authorized strike-vote procedures, though occasionally a wildcat strike may occur. Many unions have special strike funds to help support the strikers.

As soon as a strike begins, union members usually set up *picket lines* at entrances to the employer's place of business. The pickets carry signs telling why they are on strike. The purpose of the picket line is to turn away other workers, to discourage customers, and to keep goods from being taken into or out of the plant. Union members usually refuse to cross the picket line of another union.

Strike Settlements. Most strikes are settled through negotiations between representatives of labor and management. A neutral third party may help the parties reach a settlement. In *mediation*, the third party tries to promote discussion, to work out compromises, and to find areas of agreement. A mediator has no power to force a settlement. In *arbitration*, the third party has the power to settle a strike. An arbitrator is given the power of *binding arbitration* through voluntary agreement of the parties involved or by law. Binding arbitration requires both sides to accept the recommendations of the arbitrator.

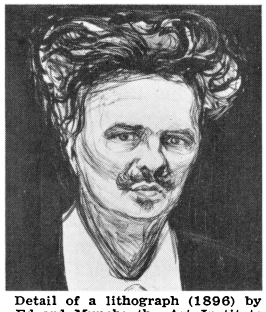
ABRAHAM J. SIEGEL

Related Articles in WORLD BOOK include:

Arbitration	Labor-Management Relations
Boycott	Lockout
Federal Mediation and Conciliation Service	National Labor Relations Board
Haymarket Riot	National Mediation Board
Homestead Strike	Pullman Strike
Industrial Relations	Railway Labor Act
Labor	Taft-Hartley Act

STRINDBERG, AUGUST (1849-1912), a Swedish writer, is one of the key figures in the history of modern drama. His experiments in dramatic form, his dynamic expression, and his brilliant language influenced the development of both naturalism and expressionism in drama. Strindberg also wrote novels, short stories, essays, poetry, and autobiographical works.

Johan August Strindberg was born in Stockholm. After some university training, he became a free-lance journalist in Stockholm. He began writing plays in 1870, and completed a fine historical drama, *Master Olof*, in 1872. He gained fame with the publication of *The Red Room* (1879), a novel about the rackets of Stockholm.



Detail of a lithograph (1896) by Edvard Munch; the Art Institute of Chicago

August Strindberg

Strindberg returned to playwriting with his famous naturalistic drama *The Father* (1887). This play tells how a wife destroys her husband by forcing him to doubt that he is the father of their daughter. *Miss Julie* (1888), a naturalistic play of social criticism, describes the tragedy of a woman of the Victorian age who loves a man beneath her social class. *The Creditors* (1888) describes the hate and pain which three persons can inflict upon one another.

Strindberg suffered much emotional and physical distress following two divorces in the 1890's. But by 1898 he had begun a new style of playwriting with *To Damascus* (parts I and II, 1898; part III, 1904). In this expressionistic trilogy, Strindberg portrayed himself as the "Unknown One," and expressed his lifelong spiritual uncertainty in dreamlike scenes and moods. In the delicate symbolic play *Easter* (1901), however, he faithfully presented Christian principles.

After the cold, brutal domestic drama *Dance of Death* (1901) and the romantic tragedy *The Bridal Crown* (1902), Strindberg again turned to an expressionistic form in *A Dream Play* (1902). This play consists of short scenes and speeches that trace the search for happiness by the daughter of the Indian god Indra. Only one other Strindberg play, *The Spook Sonata* (1907), has less plot and a more pessimistic view of life. *The Spook Sonata* is the strangest and one of the most influential of Strindberg's plays. Its disconnected dialogue, mystical images, and distorted characters had a strong influence on expressionist drama.

FREDERICK J. HUNTER

See also NATURALISM; EXPRESSIONISM.

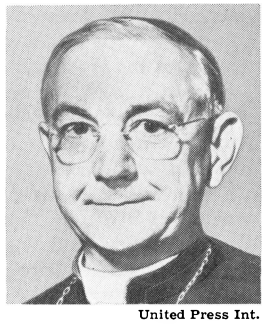
STRING. See TWINE.

STRING QUARTET. See CHAMBER MUSIC.

STRINGED INSTRUMENT. See MUSIC; ORCHESTRA; SOUND (Musical Sounds).

STRIP MINE. See COAL (Mining Methods).

STRITCH, SAMUEL A. CARDINAL (1887-1958), was named a cardinal of the Roman Catholic Church by Pope Pius XII in February, 1946. In 1958 he was named pro-prefect of the Vatican's Sacred Congregation for the Propagation of the Faith.



United Press Int.

Samuel Cardinal Stritch

Cardinal Stritch was born in Nashville, Tenn. He was an excellent student, and

was graduated from high school when he was 14. At 17, he received his B.A. degree, and after two years of study at the North American College in Rome, received his Ph.D. degree. A special dispensation was secured to permit him to be ordained when he was 23.

The future cardinal first served in Tennessee. He became bishop of Toledo, Ohio, in 1921, the youngest American ever to become a bishop. In 1930, he was named archbishop of Milwaukee, and in 1939, archbishop of Chicago. FULTON J. SHEEN

STROBILE. See CONE-BEARING TREES.

STROBOSCOPE, *STRAHB oh skohp,* is an optical device for making swiftly rotating machinery seem to stand still. It depends on the principle that the eye must take a fraction of a second to see an object.

If a machine in rapid motion is viewed by ordinary light, the moving parts are seen only as blurred masses. No details of their shapes can be seen. The eye can see only about 16 impulses per second. Faster than this it does not see anything clearly. But now, instead of using ordinary light, let us illuminate the moving machine with a single flash of lightning. The flash is bright and comes fast. As it shines on the moving machinery, everything seems to stand still.

Illumination by lightning is not practical, but artificial lightning can be made that will give bright flashes as often as we need. If the flashes are timed to synchronize with the rotation of the machine, the eye sees the machine as standing still, even though the wheels are in rapid motion. If the flashes are timed a little slower than the rotation of the machine the wheels appear to be running slowly in one direction, while if we time the flashes a little faster than the rotation, the machine appears to be running in the opposite direction. Any unwanted motion in a machine can be discovered quickly by using a stroboscope. The stroboscope also is often used to provide the lighting for high-speed photography (see PHOTOGRAPHY [Artificial Lighting]). PALMER H. CRAIG

See also DUCHAMP, MARCEL (picture).

STROESSNER, *STREHS nur,* **ALFREDO** (1912-), led a military overthrow of the government of Paraguay in 1954 and later that year was elected president without opposition. He was re-elected in 1958, 1963, 1968, and 1973 in government-controlled elections.

Stroessner allowed little opposition to his rule. Some Paraguayans who criticized him were imprisoned, and many others fled the country. Stroessner achieved some political stability and some economic progress for Paraguay. He used loans from international agencies to improve the road and water supply systems, increase electric power production, and build new schools.

Stroessner was born in Encarnación and graduated from the Military College in Asunción. In 1951, Stroessner became the commander in chief of Paraguay's armed forces. JOHN TATE LANNING

STROKE. See APOPLEXY.

STROMBOLI, *STRAHM boh lih,* is an island in the Tyrrhenian Sea off the northeastern coast of Sicily. The island covers 4.7 square miles (12.2 square kilometers) and has 559 people. It is famous for its volcano, which rises 3,038 feet (926 meters) high. The volcano is one of the few in Europe that are constantly active. Ancient writers reported this activity centuries ago. Disastrous eruptions rarely occur because the lava flows freely instead of building up internal pressure for violent eruptions. For the location of Stromboli, see ITALY (physical map). SHEPARD B. CLOUGH

STROMEYER, FRIEDRICH. See CADMIUM.

STRONG, SIR SAMUEL HENRY (1825-1909), served as the chief justice of the Supreme Court of Canada from 1892 to 1902. He became one of its first members when the court was established in 1875. Strong was a judge of the Court of Chancery from 1869 to 1874. He was knighted in 1893, and sworn into the Imperial Privy Council in 1897. He was born in Poole, Dorsetshire, England. J. E. HODGETTS

STRONTIUM, *STRAHN shee um,* a chemical element, is a soft, silvery, or yellowish metal. Strontium exists as many *isotopes* (atoms with the same atomic number but different atomic weights). Strontium-90 is a dangerous radioactive isotope found in the fallout from some nuclear explosions. In men and animals, the radioactivity of strontium-90 destroys the tissues that make blood.

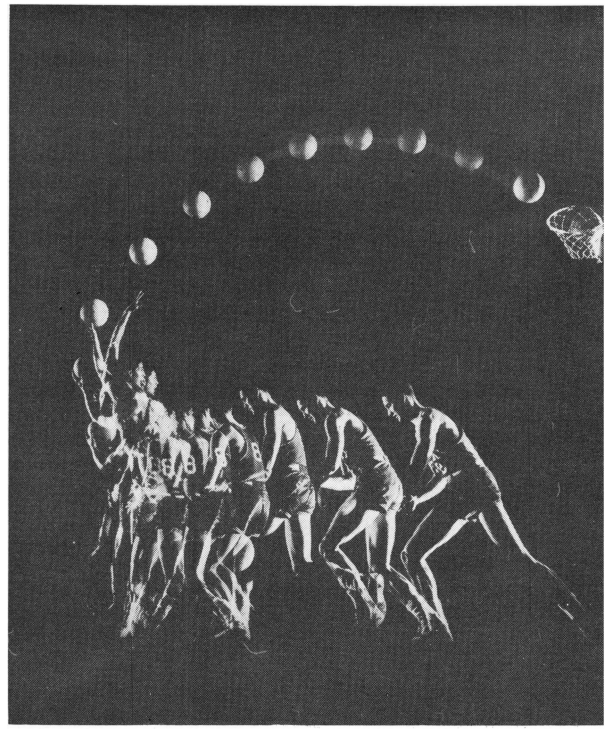
Strontium is found in the minerals celestite and strontianite. It combines readily with oxygen, nitrogen, and hydrogen. Strontium nitrate ($Sr[NO_3]_2$) burns with a crimson flame, and is used in flares and fireworks.

Strontium has the chemical symbol Sr. Its atomic number is 38 and its atomic weight is 87.62. It melts at 769° C and boils at 1384° C. It was discovered in 1790 by Adair Crawford of Ireland. WARREN S. PETERSON

STRUCTURAL ENGINEERING. See ENGINEERING (Civil Engineering).

Split-Second Flashes of Light from a Stroboscope make it possible for a photographer to record a basketball player's action as he dribbles down the floor and takes a shot.

GJon Mili



STRUCTURAL FORMULA. See CHEMISTRY (Structural Formulas).

STRUCTURALISM. See PSYCHOLOGY (History).

STRUGGLE FOR EXISTENCE. See EVOLUTION (Darwin's Theory); NATURAL SELECTION.

STRUTT, JEDEDIAH. See KNITTING MACHINE.

STRUVE, *SHTROO vuh*, **OTTO** (1897-1963), was an American astronomer. He contributed greatly to knowledge of stellar evolution. Struve was director of the Yerkes Observatory from 1932 to 1947, and of the McDonald Observatory from 1939 to 1947. Struve became professor of astronomy and director of the Leuschner Observatory at the University of California in 1950. He was born in Russia. HELEN WRIGHT

STRYCHNINE, *STRICK neen* (chemical formula, $C_{21}H_{22}N_2O_2$), is a bitter and poisonous drug obtained from the seeds of plants such as the *nux vomica* tree, found in India and Indonesia. Strychnine comes in colorless crystals. A large dose of strychnine causes a serious case of poisoning, resulting in convulsions. The usual symptoms are twitching, difficulty in swallowing, and a sudden backward bending of the body. If a person has taken strychnine, call a doctor immediately. If the victim is not having convulsions, try to make him vomit by touching the back of his throat with the blunt end of a spoon or your finger. The victim should be kept warm and as quiet as possible. A. K. REYNOLDS

See also NUX VOMICA.

STUART, GILBERT CHARLES (1755-1828), was an American artist. He became famous for his unfinished portrait of George Washington, probably the best-known portrait in America.

Stuart was born near Newport, R.I., and began painting at the age of 13. His early works were simple, thinly painted portraits. In 1775 he went to London for five years to serve as assistant to artist Benjamin West. A Stuart portrait, *The Skater*, was exhibited at the Royal Academy in 1782. This graceful, luminous picture received so much praise that Stuart opened his own portrait studio in London. For the next 10 years, the wealthy of England and Scotland sat for him. However, Stuart lived in high style and spent some time in British debtors prisons because of his extravagant living.

In 1792, Stuart returned to the United States. He planned to get money to pay his debts by painting Washington's portrait. Washington sat for three different portraits in 1795 and 1796. The "Vaughan" type is a completed painting of bust length. "Lansdowne" is a full length portrait. "Athenaeum" is the familiar unfinished oval of Washington's head. Stuart sold many copies of the portraits that he, his daughter, and others made.

Stuart spent the last half of his life as a portrait painter. He became noted for his charm, his ability to complete portraits quickly, and his advice to young artists. "Paint what you see," he told a beginner, "and look with your own eyes." EDWARD H. DWIGHT

For reproductions of Stuart's works, see ADAMS, JOHN; ASTOR; GALLATIN, ALBERT; JEFFERSON, THOMAS; MONROE, JAMES; WASHINGTON, GEORGE. See also RHODE ISLAND (A Visitor's Guide).

STUART, HOUSE OF. Stuart is the name of a royal family of England and Scotland. The Stuarts were kings of Scotland from 1371 to 1603, and kings of England and Scotland from 1603 to 1714. Their rule of the two countries in the 1600's was characterized by their insistence on the Divine Right of Kings (see DIVINE RIGHT OF KINGS).

James VI of Scotland, the son of Mary, Queen of Scots, became king of England at the death of his cousin, Queen Elizabeth I, in 1603. He took the title of James I. His son Charles I succeeded him. Charles's attempt to rule as a dictator brought on the English Revolution. He was beheaded in 1649.

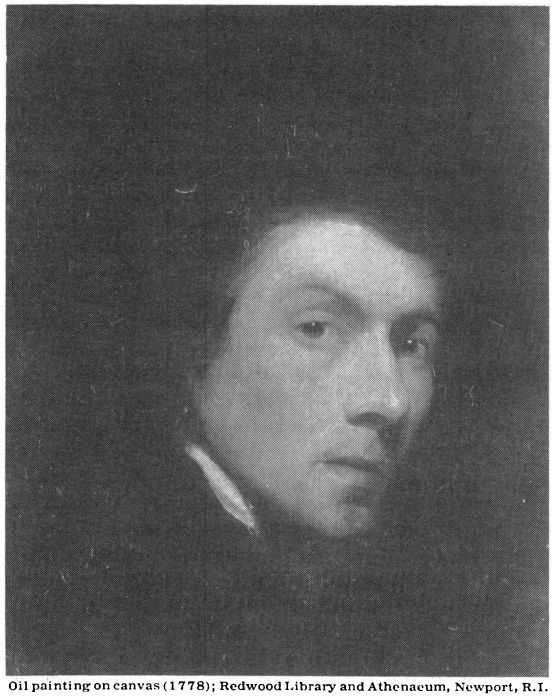
England again became a monarchy in 1660 under Charles II, the son of Charles I. When Charles II died in 1685, his brother, James II, became king. James was determined to rule as a dictator and to restore the Roman Catholic religion in England, even though England was committed to parliamentary government and was strongly anti-Catholic. As a result of this conflict, James was forced to leave the throne in the bloodless revolution of 1688. Parliament gave the crown to his daughter Mary and her husband, William of Orange.

Anne Stuart, Mary's sister, became queen in 1702. She was the last Stuart ruler. During her reign, England and Scotland were united as a single nation known as Great Britain. W. M. SOUTHGATE

Related Articles in WORLD BOOK include:

Anne	James (I; II)
Charles (I; II)	Mary (II)
of England	Mary, Queen of Scots
England (History)	Scotland (History)

STUART, JAMES EWELL BROWN (1833-1864), was a Confederate cavalry general. "Jeb" Stuart distinguished himself in the first Battle of Bull Run (Manassas). He



Oil painting on canvas (1778); Redwood Library and Athenaeum, Newport, R.I.

Gilbert Stuart's Self-Portrait shows how he concentrated on facial expression and neglected the background in his works.

served with "Stonewall" Jackson at Chancellorsville and commanded Jackson's corps for a short time after Jackson was wounded. In command of all General Robert E. Lee's cavalry, Stuart fought several successful actions in the Wilderness Campaign in 1864. But he had gained his widest fame for his two daring rides "around McClellan." In these rides, Stuart took his division of cavalry all the way around the Union Army.

Stuart became the center of a great controversy following the Battle of Gettysburg. He had taken his command off on an independent operation while General Lee invaded the North, and Stuart's absence deprived Lee of the "eyes" of his army. Stuart was killed at Yellow Tavern, Va., in the battle for Richmond.

Brown Bros.

"Jeb" Stuart

Stuart was born in Patrick County, Virginia, and was graduated from the United States Military Academy. He served in Kansas and on the frontier from 1855 to 1861. He resigned from the United States Army in 1861, and joined the Confederacy. FRANK E. VANDIVER

STUART, JESSE HILTON (1907-), is an American author known for his writings about the mountain region of Kentucky. Since 1934, Stuart has published more than 30 works, including novels, collections of poetry and short stories, and autobiographies. His major works show his simple, realistic style and his affection for the people of the Kentucky mountains, where he was born and raised.

Stuart's novels include *Taps for Private Tussie* (1943) and *Daughter of the Legend* (1965). Among the collections of his short stories are *Head o' W-Hollow* (1936) and *My Land Has a Voice* (1966). Collections of his poems include *Man with a Bull-Tongue Plow* (1934) and *Hold April* (1962). Stuart described his childhood and family in *God's Oddling* (1960). He based *To Teach, To Love* (1970) on his experiences as a teacher and writer. Stuart was born near Riverton, Ky. JOHN B. VICKERY

STUART, JOHN M. See NORTHERN TERRITORY.

STUART, JOHN TODD. See LINCOLN, ABRAHAM (Study).

STUART, MARY. See MARY, QUEEN OF SCOTS.

STUCCO, *STUCK o*, is a plasterlike material applied to outside walls. It forms a hard protective covering. Stucco usually consists of sand, water, and a cementing mixture. Workers usually apply three coats, using trowels. The first two are each about $\frac{3}{8}$ inch (10 millimeters) thick. The finish coat is from $\frac{1}{8}$ to $\frac{1}{4}$ inch (3 to 6 millimeters) thick. Stucco can be applied in many finishes and colors. See also PLASTERING. GEORGE W. WASHA

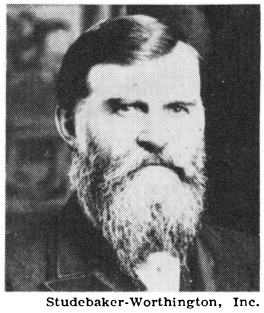
STUCK, HUDSON. See MOUNT MCKINLEY.

STUD. See HOUSE (House Building Terms); CHAIN.

STUDBOOK. See DOG (Dog Terms).

STUDEBAKER is the name of a family that became famous as makers of wagons and other vehicles. Their company, Studebaker Corporation, merged with Packard Motors, Inc., in 1954. In 1966, the firm stopped making automobiles. It continued to make automobile parts and other products. In 1967, the company merged with Worthington Corp. to form Studebaker-Worthington, Inc.

Clement Studebaker (1831-1901), with his brother Henry, opened a blacksmith and wagon shop in South Bend, Ind., in 1852. The Studebaker Brothers Manufacturing Company was organized in 1868, with Clement as its first president. The company became the largest wagon manufacturer in the country, and had a world market. Studebaker was born in Pinetown, Pa.



Studebaker-Worthington, Inc.

Clement Studebaker

Studebaker-Worthington, Inc.

John M. Studebaker

John Mohler Studebaker (1833-1917), a brother of Clement Studebaker, moved to California in 1853 during the Gold Rush. There he made wheelbarrows for the miners. When he had saved enough money, he returned to South Bend and bought his brother Henry's interest in the Studebaker firm. John Studebaker became president of the company after Clement died. In 1902, the firm made its first electric-powered vehicles, and in 1904 it began making gasoline-powered cars. By 1920, the Studebaker company was producing automobiles and trucks exclusively. Studebaker was born in Gettysburg, Pa. V. E. CANGELOSI and R. E. WESTMEYER

STUDENT GOVERNMENT is an activity in which students take part in the government of their school, college, or university. This activity usually takes place through a student organization. The organization may be called a *student cabinet*, *student congress*, *student legislature*, or *G.O.* (general organization). But most are called *student councils*. Most high schools, colleges, and universities have some form of student government.

Students elect representatives to the council, and the council works to promote student welfare. The council meets with the faculty and school administration to discuss curriculum, student life, alumni relations, and other matters which are of interest to the students. A faculty member serves as the council sponsor or adviser. Council activities in school include directing assembly programs, planning and directing honor study halls, coordinating student activity programs, helping to manage the school cafeteria, arranging celebrations for special days, and directing awards programs. The student council may also join in community projects and it may direct leadership and citizenship education programs.

About 10,000 high schools in the United States belong to the National Association of Student Councils (NASC), which distributes information about student

government. Headquarters of the association are at 1201 Sixteenth Street NW, Washington, D.C. 20036.

About 340 collegiate student organizations belong to the United States National Student Association (USNSA). USNSA sponsors student exchange programs and meetings on current student and world problems. USNSA delegates may also represent United States students at international meetings. GORDON J. KLOPF

STUDENT NATIONAL COORDINATING COMMITTEE (SNCC), also called "Snick," is a civil rights organization in the United States. White and Negro students founded SNCC in 1960 as the Student Nonviolent Coordinating Committee. The group adopted its present name in 1969. In the early 1960's, SNCC organized peaceful protests and demonstrations to speed desegregation in the South. In 1964, SNCC sponsored the Mississippi Project, in which about 800 volunteers helped thousands of Negroes register to vote.

Under the leadership of Stokely Carmichael, SNCC abandoned its policy of nonviolence in 1966. It adopted a strong antiwhite attitude, and discouraged white membership. Carmichael criticized the civil rights movement, and called for "Black Power." Carmichael resigned as leader of SNCC in 1967. He denounced the United States during a tour of the world. His successor, H. Rap Brown, continued the strongly militant program started by Carmichael. RICHARD BARDOLPH

See also CARMICHAEL, STOKELY.

STUDENT NATIONAL EDUCATION ASSOCIATION. See NATIONAL EDUCATION ASSOCIATION OF THE UNITED STATES.

STUDENT NONVIOLENT COORDINATING COMMITTEE. See STUDENT NATIONAL COORDINATING COMMITTEE.

STUDENT PROTEST. See RIOT (During the 1900's); NEW LEFT.

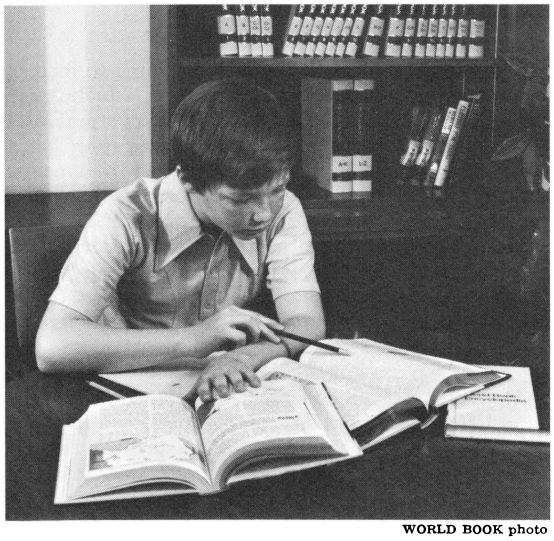
STUDENTS FOR A DEMOCRATIC SOCIETY (SDS) was a radical political organization in the United States during the 1960's. Most of its members were college students or other young people. They opposed what they believed to be the hypocrisy of American society.

SDS members believed that American society theoretically supports liberal democratic principles but has failed to correct such injustices as poverty and racial discrimination. SDS strongly opposed U.S. participation in the Vietnam War and tried to arouse public opinion against the war. The organization also demanded more student influence in the administration of colleges and universities. SDS believed that these institutions do not respond to young people's needs and wishes, and smother their ideas and personalities.

SDS tactics included propaganda and such direct action as student strikes and mass demonstrations. The organization was often accused of using or provoking violence to advance its demands.

SDS was organized in 1962. Many of its ideas came from *Marxism*—the teachings of the German philosopher Karl Marx—and from *anarchism*, the belief that all government and law are evil. But SDS was not united on its ideas and tactics, and internal disputes reduced the effectiveness of the organization. In the late 1960's, SDS split into several factions. MURRAY CLARK HAVENS

STUDIO. See MOTION PICTURE; RADIO (How Radio Programs Are Broadcast); TELEVISION (Producing Television Programs; pictures).



WORLD BOOK photo

A Good General Encyclopedia is a collection of man's knowledge. It is an invaluable study aid for almost every subject.

STUDY means to apply the mind to any subject in order to learn about it. Study is accomplished mostly by means of reading, observation, questioning, listening, and reflection. It is an important part of the process of learning. The purpose of study is the discovery and understanding of information. A good student obtains facts and learns skills by which he can organize and express his thoughts and talents.

Effective Study

Effective or successful study consists of much more than merely memorizing facts. It calls for knowing where and how to obtain facts, and the ability to make intelligent use of them. It means that the student must be able to organize, classify, and arrange facts in their proper relationship to the subject being studied. A student must decide what is important information and then form opinions concerning it. All these things must be done to the best of his ability in the shortest possible amount of time. Because knowledge is important to every person, it is wise to learn how to study in the most effective way. See LEARNING (Efficient Learning).

Aids to Effective Study

Good Physical Condition. The mind works best when the body is in good physical condition. Good health demands that we eat properly and get enough rest, sleep, exercise, and recreation. Certain physical defects make study especially difficult. Poor eyesight, for example, can be a great hindrance to study and should be corrected. But many physical handicaps need not prevent one from learning to study efficiently. A crippled child, for example, may learn to study as well as anyone.

Favorable Surroundings. Every child needs a place where he can study regularly without interruption. He must have a desk or table and a chair. Both must be of the proper height to fit his body. Good light, either daylight or artificial light, is necessary to prevent eyestrain. The desk or table should be located so that the light will fall over the left shoulder on the reading mat-

ter. The amount of light should be enough to read by easily but not so much as to cause glare, which results in eye fatigue. Noise and other distractions should be eliminated. Some people feel that they can study better with soft music in the background. But most people find the radio or television a distraction. The room temperature should be neither too hot nor too cold.

Study Materials. Certain study materials are usually required by the student. They include pencils, a pen, ink, erasers, paper, notebooks, scissors, rubber bands, and paper clips. Additional equipment will be needed for certain subjects. Geometry may call for a compass, a ruler, and a protractor. Besides the required textbooks, a comprehensive dictionary, a readable general encyclopedia, a comprehensive atlas, and other reference works will provide valuable aid. Some provision should be made for keeping notes and work papers in an orderly arrangement so they are ready for quick reference. File folders, properly labeled and indexed, are useful for this purpose. A bookshelf and drawers for storing materials encourage neatness and systematic work. A typewriter may help some students do more work in less time and make their work more presentable.

Regular Habits. Every human being is subject to habits, and the sum of his habits determines his character. The body and mind perform various functions more easily when they are taught to do so at regular intervals. For example, if we are accustomed to eating dinner at a certain hour, we normally become hungry at that time. Likewise, if a definite period of the day is set aside for study, the mind is more likely to be ready for study. The art of studying effectively can be acquired only with regular practice. If we neglect to study one day, it is easy to neglect to study the next day.

Reading Ability. Effective study depends more than anything else on the ability to make the best use of the printed word. Rapid reading is essential in order to cover as much ground as possible without wasting time. The art of reading rapidly, and with understanding, can be developed with practice. Every student should try to improve his reading by improving his vocabulary, his speed, and his comprehension. See READING.

The student cannot always determine immediately how helpful a book may be to the subject being studied. In that case, it is better to skim through the book quickly at first, instead of reading it word by word. In this way, the main points and general meaning are quickly grasped. If the material proves to be helpful, a second and more careful reading can follow. Some students find it helpful to underline key ideas or summary sentences in their textbooks. A review of this material refreshes the memory of important ideas, principles, and concepts. This procedure is suggested only if the book belongs to the student.

Too many students fail to understand all that they have read because they do not know the meaning of some words. If a word is unfamiliar, it is a good habit to take time to look it up in the dictionary and learn its meaning. By analyzing the organization of material, a picture of what has been read can be formed in the mind. Try to grasp essential facts and sort these out in some kind of order. The important thing is to remember the idea, rather than the author's exact words.

Read critically in order to compare the statements of one author with those of another. A subject can often be presented from different points of view. The student should not form an opinion until the subject has been considered from more than one angle. Nor should he believe everything he sees in print.

If there are questions at the end of a lesson or chapter, it is a good idea to try answering the questions first, on the basis of what you know. The actual reading of the lesson then becomes a process of checking and making certain the answers are correct.

Studying Together. Two or three students can often get good results and save a great deal of time by studying together. One interesting and effective method is for each student to prepare each day's lesson not by "studying" it, but by going through it rapidly in order to prepare a test or examination for the others. Each one then takes the test prepared by the others. The whole group scores its papers together.

Efficient Use of Text and Reference Books. Text and reference books contain many aids to study. The table of contents in the front of a textbook lists the chapters and may provide a brief description of what each contains. An index at the back of the book gives an alphabetical list of names and subjects referred to in the book, with the pages where the topics may be found.

Both encyclopedias and dictionaries contain many *cross references* and *related subjects*. These aids lead the reader from the article he is reading to other articles that will provide additional information.

Many general encyclopedias have a separate index volume. This volume helps the student extend his interest in a subject by showing the interrelationships of a variety of articles.

Many encyclopedias and textbooks include *bibliographies*. A bibliography is a list of books on a subject for further reading. Reference books also have charts, diagrams, and outlines. These should be studied because they are the author's means of summarizing information. Other aids to study include vocabulary lists, pronunciation guides, photographs, and maps.

Cultivate the habit of using all aids to locate material quickly. Learn how to use such basic reference materials as an atlas, an almanac, an encyclopedia year book, and the card catalog in the library (see LIBRARY).

Understanding the Assignment. No subject can be studied effectively unless the student has a clear understanding of the work he is supposed to do. Write out each day's assignment and make a note of what is to be read, the problems to be worked out, and what must be prepared in writing. Ask the teacher to explain any points that are not clear. Take advantage of any directions or suggestions that are offered.

Planning the Work. Plan carefully how to use your time to best advantage. Some students take a few minutes each morning to plan a schedule of their day's activities. Many students find it helpful to make a weekly schedule allowing adequate time for study. A study program should be kept flexible so that adjustments can be made as they are needed.

Schedule your study for a time when you are least tired. Study your most difficult subject first when you are freshest mentally and physically. The easiest subjects should ordinarily be left to do last, unless you become inclined to pass over them too lightly because

they are so easy. Plan to keep study periods short and take a few minutes of rest between subjects.

Taking Notes. Cultivate the habit of taking notes in outline form both while reading and during classroom work. Notes provide a ready source of reference, and they also help you to fix a subject in mind. Do not attempt to write down every word you read or hear. Instead, learn to select essential facts and sum them up in the fewest possible words, using key phrases and abbreviations. To do this efficiently requires considerable practice. But a few well-chosen words can serve as pegs on which to hang ideas. After class, look over your notes and fill in any material you may have missed. The process of reducing a subject to outline form will help in learning how to take effective notes. The outline should be well organized and clear. A good outline is brief enough to allow the student to learn the concepts easily. See OUTLINES AND OUTLINING.

Develop some system of filing notes so that they can be easily located when they are needed. No elaborate filing system is needed, but the exact method to use depends on the type of work being done. Perhaps all that is needed is a single folder to hold the notes for each of your subjects.

Keeping Work Up to Date. Nothing can be gained by putting off work from one day to another. You cannot study twice as hard in one day to make up for time lost during another. Each day's lesson must be prepared regularly for rapid progress. But sometimes you may miss work because of illness or for some other unavoidable reason. In that case, extra study time must often be allowed in order to bring the work up to date. Special assistance from your teachers or parents may be needed if you have missed a number of lessons.

Concentration. It is essential to keep in mind the subject to be studied. This can be accomplished only by mental discipline. The mind is often tempted to wander, sometimes even from an interesting subject. Mental discipline is a habit that can be cultivated only through constant effort. Concentration means that you must think only about the work at hand. If part of the mind is waiting for a telephone call or listening to the radio or television, the rest of the mind cannot concentrate on study.

Some subjects stimulate us naturally, and we enjoy studying them. Others may require a real effort of the will. But no subject need be dull if it is approached with a determination to master it. A subject sometimes only seems dull because we do not understand the reasons for studying it. After its purpose is explained, it may become interesting.

Many reference books contain material other than that about the subject being studied. Sometimes such material may seem so interesting that we are distracted from the work at hand. This temptation must be vigorously resisted until the necessary tasks are accomplished. After the assignment is finished, it may be profitable to turn our attention to any subject we care to pursue. Investigation of this kind can be stimulating to the mind. But to indulge in it before our work is done is as unwise a practice as eating candy before dinner.

Frequent Review. Each day's study should begin with a quick review of the previous lesson. This helps to fix in mind the points already learned and to form a bridge to the next assignment. All the work covered during a semester should be reviewed at frequent intervals. Well-kept notes are helpful for this purpose. Never wait until the day before an examination to review the work for an entire period. "Cramming" is the most inefficient method of study, and what is learned in this way is usually soon forgotten. Remember that passing examinations is not the most important purpose of study.

Observation. Not all study should be done from books. Everything about us is material for study. We can learn much about nature by reading books. But we can learn even more by observation. It is not enough merely to look. We may look without actually seeing. Instead, we must look carefully and think about what we see. Then we begin to wonder and to ask ourselves questions. The answers may be found in books, or we may discover them for ourselves. Knowledge found in this way becomes a permanent part of us.

Museums offer rich sources of material for study. Some of them are mines of information about the past. History comes to life when we see actual examples of furniture, clothing, painting, or sculpture that were used or made by people in other times.

We can learn more about animals by studying live ones in zoos than by looking at pictures in books. And natural history museums present realistic exhibitions of stuffed animals in their natural settings, which most zoos cannot do.

Application. Study has much more meaning if what has been learned is applied to a practical purpose. For example, you might put arithmetic to use by offering to add and check the family grocery bill. A student of home economics may be able to suggest improvements in the family's diet. All recreational activities offer opportunities to put into use something that has been learned in the classroom.

Discussion and Self Tests. We gain better understanding of a subject when we learn to express our ideas about it in our own words. This should be done both in writing and orally. Oral discussion stimulates quick thinking, and a written analysis aids careful thinking. You should test your knowledge of a subject by asking yourself questions and then checking the answers with what you have already studied.

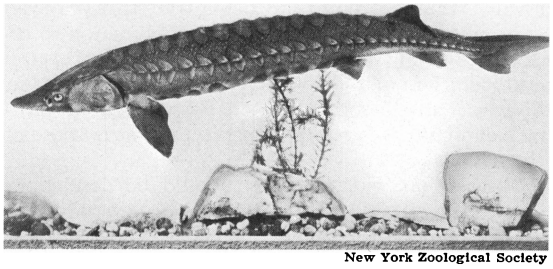
Discussions may take place in class. But they also may be continued outside of class with fellow students, members of the family, or older friends.

Mental Attitude. A happy outlook of mind helps you to study better. Worries or fear prevent concentration. The cause of a worry may exist only in your mind. Many such worries can be overcome by discussing them with friends, parents, or teachers. Fear of failing in your lessons can sometimes actually prevent effective study. But common sense and reason can help get rid of such fears. Seek the advice of parents and teachers or of someone in whom you have confidence. Your counselor or school adviser will often be able to help you understand your problems more clearly. Having faith in yourself is important to successful study. WILLIAM H. NAULT

Related Articles in WORLD BOOK include:

Bibliography	Education	Outlines and Outlining
Dictionary	Encyclopedia	Reading

STUKA. See AIR FORCE (picture: Fighting Planes).



New York Zoological Society

The Rock Sturgeon has armor of bony plate to protect its head and body. Sturgeon eggs are used to make caviar.

STURGEON, *STUR jun,* is the common name of a family of large fishes living in the fresh waters and seas of the North Temperate Zone. They are caught for their flesh, which is usually smoked, and for their eggs, which are used in the preparation of caviar. A superior quality of isinglass is obtained from the air bladder of the Russian sturgeon. These fish have slender bodies covered with rows of bony plates. Beneath the long snout there is a small, toothless mouth with thick, sucking lips. There are four *barbels* (fleshy projections) in front of the mouth. The head, like the body, is well protected with plates. A single dorsal fin rises from the back, and the body extends into the long upper part of the tail fin. Most of these fish migrate from salt water into streams in the spawning season, but some species live permanently in fresh waters. Sturgeon suck food into their mouths.

Sturgeon belong to an ancient group of fish. Early ancestors of the sturgeon appeared in the Devonian Period (see EARTH [table]). The fish's sucking mouth and plated body are features that developed later.

One of the best-known sturgeon is the *common sturgeon.* It lives in European waters and along the North American coast from Labrador to the Gulf of Mexico. The largest may be over 10 feet (3 meters) long and weigh over 1,000 pounds (450 kilograms). The *white sturgeon* of the American Pacific Coast is the largest American fish of this group. The *lake* or *rock sturgeon* lives in the Great Lakes and the Mississippi Valley waters. Scientists consider the *beluga,* a sturgeon of Russia, the largest fresh-water fish. It may grow as long as 14 feet (4 meters) and weigh over 3,000 pounds (1,400 kilograms). The beluga produces most European caviar. Another Russian sturgeon, the small *sterlet,* also produces this delicacy. North American sturgeons were abundant once, but overfishing, dams, and pollution have greatly reduced their number.

Scientific Classification. The sturgeon belongs to the sturgeon family, *Acipenseridae.* The common sturgeon is genus *Acipenser,* species *A. sturio;* the white sturgeon, *A. transmontanus;* the lake or rock sturgeon, *A. fulvescens;* the sterlet, *A. ruthenus.* The beluga is genus *Huso,* species *H. huso.* CARL L. HUBBS

See also CAVIAR; FISH (picture: Fish of Temperate Fresh Waters).

STURGEON, THEODORE (1918-), is an American author of fantasy and science fiction. Most of his stories deal with the meaning of love in various kinds of human relationships. Many of his characters are abnormal human beings or beings from other worlds. But these characters seem real because Sturgeon describes them with sympathetic understanding.

Sturgeon's most important novel is *More Than Human* (1953). This book tells about a small group of young people who represent an advanced stage of human evolution. Sturgeon's short novel *Killdozer* (1944) reflects his experiences as a civilian bulldozer operator in the Caribbean during World War II (1939-1945). Many of his short stories appear in such collections as *Without Sorcery* (1949), *Caviar* (1955), *Aliens 4* (1959), and *Sturgeon Is Alive and Well* (1971). Sturgeon has also written scripts for television. He was born in New York City. JUDY-LYNN BENJAMIN DEL REY

STURGEON, WILLIAM. See ELECTROMAGNET.

STURGES, PRESTON (1898-1959), was an American motion-picture writer and director. He became famous for films that brilliantly satirize aspects of American life. *The Great McGinty* (1940) satirizes crooked politicians. *Sullivan's Travels* (1941) attacks the false values Sturges saw mirrored in Hollywood. *The Miracle of Morgan's Creek* (1944) and *Hail the Conquering Hero* (1944) deal with small-town politics and the worship of military heroes. Sturges also wrote and directed *Christmas in July* (1940), *The Lady Eve* (1941), and *Unfaithfully Yours* (1948). All show Sturges' skill at writing witty dialogue and creating slapstick comedy.

Sturges was born in Chicago. He wrote several Broadway plays before going to Hollywood in 1932. They include the Broadway comedy hit *Strictly Dishonorable* (1929). RICHARD GRIFFITH

STURLUSON. See SNORRI STURLUSON.

STURT, CHARLES. See AUSTRALIA (Exploration).

STURTEVANT, ALFRED H. See HEREDITY (Genetics).

STUTTERING AND STAMMERING are two terms used to describe a certain form of defective or disordered speech. Formerly the words were taken to mean two different defects. *Stuttering* was the repetition of sounds or syllables. *Stammering* was regarded as a continuous *block* that resulted in inability to utter any sound. Present-day specialists in speech correction do not recognize a difference between the terms. The experts use the words interchangeably, but the term *stuttering* is preferred.

An example of one form of stuttering is the inability to say clearly such words as *don't* or *animal.* The stutterer says *d-d-d-don't* and *a-a-a-animal.* A sentence spoken by a stutterer might sound like this: "M-m-m-mother, m-m-m-may Bob-bob-Bobby have a d-d-d-doughnut?"

In stuttering there may also be a spasm of the speech muscles that prevents talking, sometimes almost entirely. Often the difficulty in speaking then results in grimacing and other facial contortions which are caused by contractions of the speech muscles.

No one knows the specific causes of stuttering. Speech experts have various theories as to what causes it and many methods have been used to correct it. Shyness and lack of self-confidence often accompany it, but are not believed to cause it. About 4 to 6 times more males than females stutter. It is most common in young children. If stuttering is not overcome, it may seriously handicap a person in his own development and in his relations with others. Stuttering can become so serious that it makes a vocational failure of even a talented person. It is not associated with any lack of mental ability.

Children often lose *fluency* (smoothness of speech)

when they try to speak too rapidly, or if they are upset and excited. The condition is made worse if the speaker is aware of his defective speech. He strains to avoid the stuttering, and the effort tightens the muscles in his face and throat. This makes his speech worse. He may become panicky because of his difficulty, and thus increase the stuttering. He will gain fluency only when he stops struggling and learns to control his fear.

There are different ways in which many stutterers can use the voice easily, without stuttering. These include reading in unison, singing, speaking to groups before whom they have self-confidence, and speaking to themselves when they are alone. In general, persons who stutter find it very difficult to speak in public or in any situation in which they feel insecure.

Treatment of speech disorders is often a matter of training the mental processes and emotions, as well as retraining the speech of the individual. Each case must be treated individually, according to the person's needs. Children who stutter sometimes outgrow the defect. It is advisable not to call attention to children's stuttering and to exercise calmness and patience when they speak, in order to help them establish fluency and self-confidence. VIRGIL A. ANDERSON

See also LISPING; SPEECH THERAPY.

STUTTGART, *SHTOOT gahrt* (pop. 628,400), is the capital of the West German state of Baden-Württemberg (see GERMANY [political map]). Stuttgart was formerly capital of the state and kingdom of Württemberg. The city is the center of the printing and publishing industry of southern Germany. Stuttgart lies near the Neckar River. Many buildings in Stuttgart are fine examples of Renaissance architecture.

Bombers hit Stuttgart heavily during World War II because it contained machine-tool, ball-bearing, and internal-combustion engine factories. Many of its famous buildings were damaged. French troops entered Stuttgart on April 21, 1945. The city was in the American zone of occupation after the war. The *Läuderrat* or Council of States for the American zone was established in Stuttgart on Oct. 17, 1945. It was the first German organization above the state level to be established after the war. JAMES K. POLLOCK

STUYVESANT, *STY vuh s'nt,* **PETER** (1610?-1672), was the last Dutch governor of New Netherland, an area that included land in present-day New York and several nearby states (see NEW NETHERLAND). Stuyvesant was born at Scherpenzeel, near Heerenveen, The Netherlands, the son of a minister. He became a soldier as a young man, and in 1635 entered the service of the Dutch West India Company. In 1643, he became governor of Curaçao and nearby Dutch possessions. The next year, he led an attack against the island of Saint Martin and lost a leg in the battle.

In 1646, Stuyvesant became governor of New Netherland. He arrived in New Amsterdam (now New York City) in May, 1647, and immediately began to make enemies by his harsh methods. But he restored order and business, and made friends with the Indians. His settlement in 1650 with the New England colonists of the eastern boundaries of the Dutch colony angered the Dutch because they thought he gave the Puritans too much territory. Five years later, he captured all New Sweden, which included lands in what are now New Jersey, Delaware, and Pennsylvania. He made New Sweden a part of New Netherland.

New-York Historical Society

Peter Stuyvesant

Stuyvesant refused to share his power with anybody. When a convention of Long Island citizens demanded a share in the government, he replied, "We derive our authority from God and the West India Company, not from the pleasure of a few ignorant subjects." In 1664, an English fleet ordered the surrender of the city. The citizens refused to support Stuyvesant, and he was forced to give in. Stuyvesant was sent to Holland in disgrace, but he returned to New York after a few years and settled on his *bouwerij* (farm), part of which later became the Bowery of New York City. Stuyvesant died there and lies buried on the site of Saint Mark's Church. He is one of the characters in Washington Irving's *Knickerbocker's History of New York.* IAN C. C. GRAHAM

See also NEW YORK CITY (History); NEW SWEDEN.

STY is an infection of one of the glands in an eyelid, usually around an eyelash. The infection, which resembles a small boil, is usually caused by a *staphylococcus* bacteria. The germs enter the root of the eyelash, grow there, and form pus. Some experts believe eyestrain is an indirect cause of sties. When people with eyestrain rub their eyes too much, germs from their hands may cause infection. White blood cells in the body usually kill the germs that cause a sty. Then the sty softens, breaks, lets out the pus, and heals. Hot moist applications can make it break more quickly. Sties often come one after another. Doctors can inoculate the patient with a vaccine made from the staphylococcus germs. When sties continue for a long time, doctors may treat them with germ-killing drugs. See also BOIL. WILLIAM F. HUGHES

STYLE, in literature and the arts, is the way thoughts or ideas are expressed by the writer or artist. See also CLOTHING; FASHION; LITERATURE (Style).

STYLE, in botany. See FLOWER (The Pistils; picture: Parts of a Flower).

STYLUS was a sharp-pointed writing instrument used by peoples of ancient times. It was made of metal, bone, or reed, and was used to engrave characters on wax or moist clay tablets. The cutting instrument that makes the grooves in a phonograph record, and the phonograph needle are called *styluses.*

STYRENE. See RUBBER (Synthetic).

STYRIA, *STIR ee uh,* now a province in the southeastern part of the Austrian Republic, was ruled by Austrian princes for many centuries. Its area is 6,327 square miles (16,386 square kilometers), and it has a population of 1,192,100. It has iron ore deposits. Graz is the capital. See also GRAZ. WILLIAM J. MCGRATH

STYROFOAM is the trade name of *polystyrene foam,* a plastic manufactured by the Dow Chemical Company. Styrofoam contains millions of tiny air bubbles that make it lightweight and a poor conductor of heat. Styrofoam absorbs water only slightly, and bacteria and molds cannot damage it.

STYRON, WILLIAM

Styrofoam has many household and industrial uses. Manufacturers use it in making such household products as ice chests, disposable drinking cups, and toys. Industry uses Styrofoam as a protective packaging material for such delicate products as radios and television sets. Styrofoam is also used to insulate buildings, freight cars, and trucks. KENNETH SCHUG

See also PLASTICS (Making Synthetic Resin; The Plastics Industry Grows).

STYRON, WILLIAM (1925-), an American novelist, became one of the most promising writers to appear since 1950. His works are noted for their distinctive style and often for their Southern setting.

Styron's first novel *Lie Down in Darkness* (1951) describes the decline of a Southern middle-class family. The short novel *The Long March* (1953), set in a Marine Corps training camp, raises serious questions about the value of military discipline and routine. *Set This House on Fire* (1960) is an original and powerful novel of conflict in a small Italian town. *The Confessions of Nat Turner* (1967) re-creates the 1831 revolt of Virginia slaves led by an educated Negro minister who was dedicated to the destruction of the white man. The novel won the 1968 Pulitzer prize. Styron was born in Newport News, Va. ROBERT A. CORRIGAN

STYX, *stiks*, was a dark and dreary river in Greek and Roman mythology. The boatman Charon carried the souls of the dead across either the River Styx or the Acheron River to the Lower World. The gods took their most sacred oaths by the name of the River Styx.

The kingdom of Hades was on the other side of the Styx. After being judged, the dead souls remained in Hades or were sent to the happy Elysian Fields or to the dismal land of Tartarus. A high waterfall in Arcadia, an ancient Greek state, was also called the Styx. People believed its waters were poisonous and that the entry to the Lower World lay behind it. PADRAIC COLUM

See also CHARON; ELYSIAN FIELDS; TARTARUS.

SUÁREZ, *SWAH rayth*, **FRANCISCO** (1548-1617), was a great Spanish theologian, and a founder of the philosophy of international law. In his famous treatise *On Laws*, he attacked the theory of the divine right of kings, and insisted on the necessity of the consent of the people in a just political order. Suárez saw that the medieval idea of a Christian empire was no longer possible with the emergence of self-governing national monarchies. Suárez was born in Granada. He became a Jesuit in 1564. JAMES A. CORBETT and FULTON J. SHEEN

SUBCLAVIAN ARTERY. See ARTERY (Principal Arteries); BLOOD (color picture).

SUBCONSCIOUS is a term used to describe mental processes such as thoughts, ideas, and feelings that go on in a person's mind without his being aware of them. Psychiatrists, psychoanalysts, and psychologists generally use the term *unconscious* to mean the same thing that most nonmedical persons mean by *subconscious*. Other words that once had the same meaning include *coconscious* and *paraconscious*.

The existence of mental processes that are active in the mind without being conscious was first studied scientifically by the French neurologist Jean Charcot and his pupils in the 1800's. They studied the unconscious by means of hypnosis (see HYPNOTISM). Soon after, doctors realized many mentally ill persons, such as those with hysteria, were influenced by unconscious thoughts and feelings (see HYSTERIA; MENTAL ILLNESS).

The doctor who first realized clearly the importance of unconscious thoughts and feelings in human psychology was Sigmund Freud of Austria. He developed the method of *psychoanalysis* for treating mentally ill patients (see PSYCHOANALYSIS). This method also serves as a way of learning what goes on unconsciously in a patient's mind. By using psychoanalysis, Freud was able to prove that unconscious thoughts and feelings not only produce the symptoms of many types of mental illness, but that they are also of basic importance in the way the minds of normal people work. This knowledge has enabled doctors to make great advances in the treatment of the mentally ill. CHARLES BRENNER

Related Articles in WORLD BOOK include:

Dream	Nightmare	Sleepwalking
Freud, Sigmund	Phobia	Subliminal
Neurosis	Psychotherapy	

SUBINFEUDATION. See FEUDALISM (Knighthood).

SUBJECT. See CITIZENSHIP (Modern Times).

SUBJECT, in grammar. See SENTENCE (Subject and Predicate).

SUBJUNCTIVE MOOD. See MOOD.

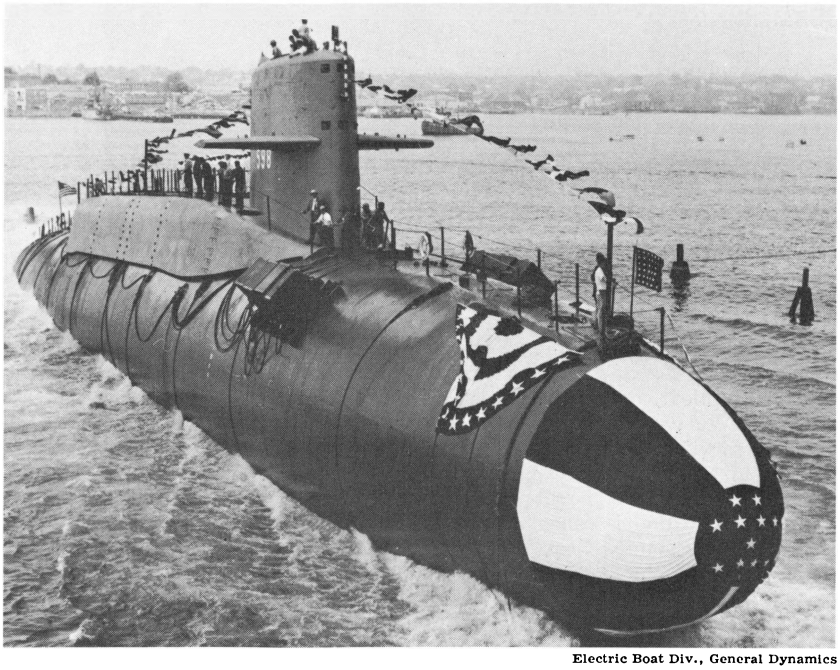
SUBLETTE, *SUB let*, **WILLIAM LEWIS** (1799?-1845), was an American fur trader and merchant. He was born in Lincoln County, Kentucky, but grew up in St. Charles, Mo. He left Missouri in 1822 to become a trapper. He and his two partners were successful, and in 1831 their fantastic catch brought $170,000. Sublette next operated trading posts on the Platte and Upper Missouri rivers. He helped open the Oregon Trail by using wagons in the Rocky Mountains, and by finding a shortcut, *Sublette's Cutoff*. HOWARD R. LAMAR

SUBLIMATION, *sub luh MAY shun*, is the process by which a solid substance changes into a gas, or vapor, without first becoming a liquid. There are a few substances, such as iodine, arsenic, camphor, and dry ice, which change into a gas without first melting. These substances are said to *sublime*. The most familiar example of sublimation can occur when wet clothes are hung out on the line on a winter day when the temperature is below freezing. The water on the clothes freezes and then evaporates into vapor without melting. Solid iodine will change into a vapor when it is warmed without becoming a liquid. Then, when the vapor is cooled, the iodine will change back into crystals. This change of a vapor back into a solid also is part of sublimation.

Sublimation is used in industry to purify substances. When a solid changes directly into a vapor, only the pure substance evaporates and the impurities remain. Pure sulfur (called *flowers of sulfur*), benzoin, and sal ammoniac are made by this process. RALPH G. OWENS

SUBLIME PORTE. See TURKEY (The Ottoman Empire).

SUBLIMINAL, *sub LIHM ih nul*, refers to stimuli that are so weak or last so short a time that a person is not aware of them. Such stimuli are said to be *subliminal* (below the threshold of consciousness). The consciousness threshold varies from person to person and from time to time, even in the same person. Psychologists have been trying to determine whether subliminal stimuli can influence people, perhaps through the unconscious. Some use has been made of such subliminal stimuli in advertising. RUSSELL M. CHURCH



Electric Boat Div., General Dynamics

Ballistic-Missile Subs such as the U.S.S. *George Washington* can fire long-range ballistic missiles at distant shore targets from under the surface of the sea.

SUBMARINE, *SUB muh* REEN, first achieved widespread use as a weapon of war during World War I. Almost immediately, it proved its worth as a vessel that could hide beneath the surface of the sea and attack enemy warships and merchant ships. Submarines played an even greater role during World War II. The United States Navy estimates that submarines are responsible for three-fourths of all damage inflicted on ships at sea during wartime. During World War II, U.S. Navy submarines accounted for two of every three large Japanese merchant ships sunk and about one of every three Japanese warships.

Submarines are becoming even more important. With nuclear power, they can cruise underwater for almost indefinite periods. Some naval authorities believe that ballistic missile submarines will be the most important strategic force in an all-out nuclear war.

What a Submarine Is

A submarine is a ship designed and built to operate under water. Its shape is quite different from that of a surface ship. Most submarines are shaped much like a cigar, with tapered ends and an almost round body. They have propellers and steering gear at one end, and diving planes near the other. Many submarines have a tall *conning tower* from which the ship is navigated when it is on the surface. The conning tower also contains the periscope for observing the surface when the submarine is submerged. Many recent submarines have a tall streamlined *sail* instead of a conning tower. The sail contains the submarine's bridge and navigation room, and is used both on and under the surface.

The U.S. Navy has developed submarines with a rounded, fish-shaped body and a blunt, round nose. These submarines create less water-resistance than surface ships, and can go faster under water.

Every submarine has a double *hull* (shell) with a space in between for air or water. The inner hull must be strong to withstand the great pressure of water when it is below the surface. This pressure reaches 88.9 pounds per square inch (6.25 kilograms per square centimeter) of hull surface at a depth of 200 feet (61 meters). The space between the hulls fills with water, so the outer hull does not have to withstand such pressure, because it is surrounded by water.

Power. Prior to nuclear power, all submarines had diesel or gasoline engines for surface operations, and electric motors for underwater operations. They had to use electric motors under water, because such motors do not require air to operate. They used batteries to run their motors, and spent much time on the surface, recharging the batteries. They could travel about 20 knots (37 kilometers per hour) on the surface, but only about 10 knots (19 kilometers per hour) submerged.

German submarines used the *snorkel*, a long breathing tube, to provide air for the engines under water. The intake and exhaust valves are contained in a device that takes in a constant supply of air. R. J. J. Wichers of The Netherlands developed the snorkel. Snorkel-equipped submarines could stay under longer, and move faster, than regular submarines.

Atomic power gives submarines far greater possibilities for operations under water. Nuclear power plants do not need oxygen to work, so submarines can stay under water for an almost unlimited time. And nuclear power can produce far greater speeds than conventional power. Nuclear-powered submarines have broken all earlier records for speed, endurance, and time submerged.

Purposes. Submarines serve several basic purposes. The most common use in World Wars I and II was to submerge and attack warships and merchant ships on the surface. With the development of ballistic missiles, the navy worked on submarines that could fire weapons with atomic warheads at targets as much as 1,500 miles (2,410 kilometers) away. And, with the growing threat

of enemy submarines, navy planners worked on submarines that were designed to attack and destroy enemy submarines under water.

Submarines have also been used for many other kinds of work. They can lay mines, land small groups of men for work ashore, pick them up, pick up survivors, and act as sentries to guard shipping lanes.

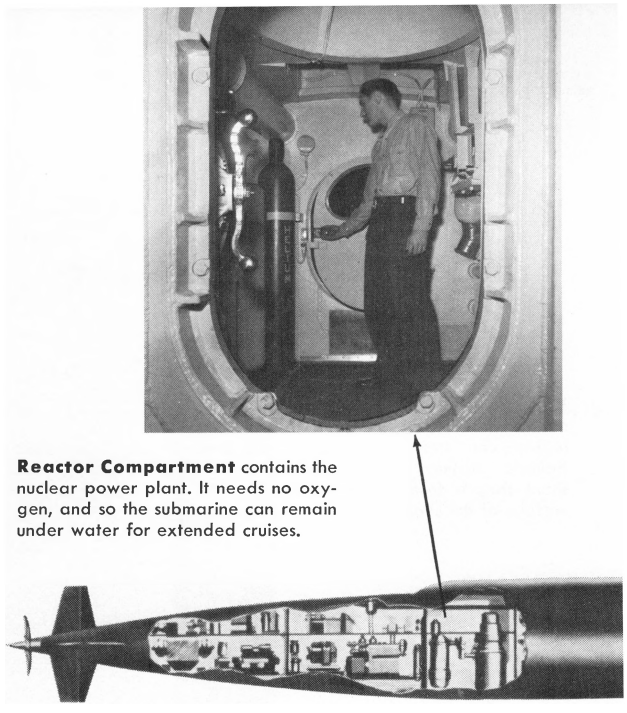
How a Submarine Operates

On the Surface, a submarine behaves much like any other ship. It has a rudder at the stern, and can be handled like other surface ships. But, to submerge, the submarine uses *ballast tanks* which can be filled with water or emptied, causing the submarine to submerge or surface. When a submarine is in proper readiness for diving from the surface, the total volume of the main ballast tanks that can be flooded exactly equals the unsubmerged volume of the submarine above the waterline. This condition is called *diving trim*. Submarine officers must constantly check the everyday changes in weight that result from using fuel, ammunition, and food, in order to vary the water ballast necessary to keep the ship in diving trim.

Diving, the submarine takes water into its ballast tanks by releasing the air pressure that kept the water out. To submerge, the diving control officer floods the main ballast tanks. The weight of the added water makes the submarine sink. Officers also set the diving planes to control the angle at which the submarine sinks. When the ship nears the desired depth, the diving control officer blows water out of the *negative tank*. He blows out enough water to put the submarine in a condition of *neutral buoyancy*, in which it does not tend to either rise or sink. The submarine can then be leveled off at the proper depth by means of the diving planes. Most navy submarines can dive to a depth of 60 feet (18 meters) in this way in about 30 seconds.

Submerged, a conventional submarine switches to its battery-driven electric motors. Nuclear-powered submarines continue to use their normal engines. From *periscope depth*, the ship's officers can watch activity on the surface with the reflecting mirrors of the periscope. By adjusting its diving planes, the submarine can move up or down in the water. To dive much deeper, it must again flood the negative tank until it reaches the new depth, and again blow the tank. *Trim tanks* at each end of the ship, and others on each side, help keep the submarine on an even keel.

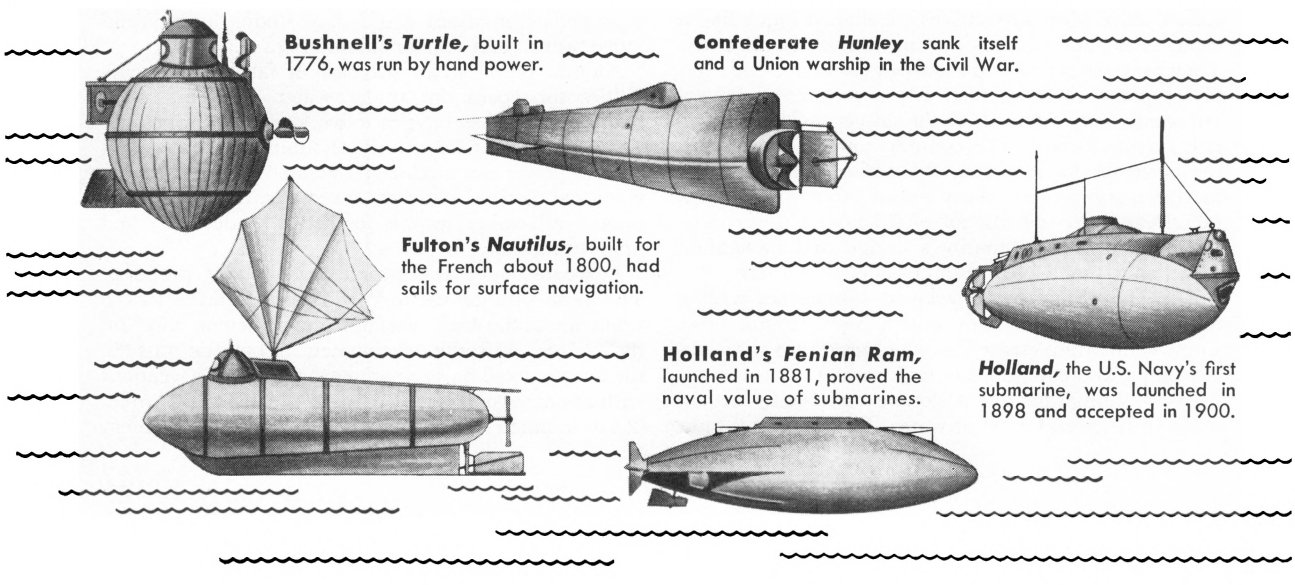
Surfacing, the submarine sets its diving planes to rise to the surface and blows all the water from its ballast tanks. The diving control officer can regulate the speed and angle of the ship's rise by varying the angle of the diving planes and the pressure used to blow



Reactor Compartment contains the nuclear power plant. It needs no oxygen, and so the submarine can remain under water for extended cruises.

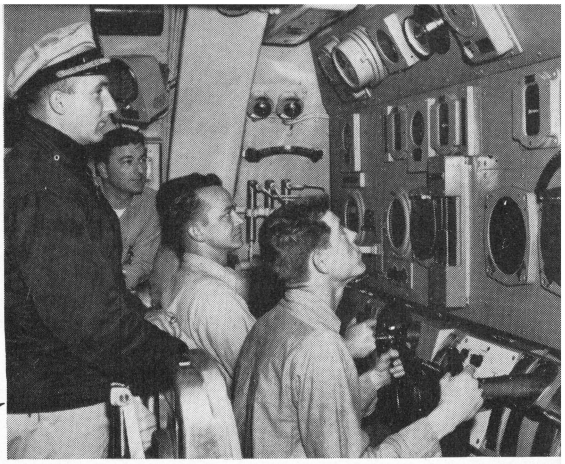
Life on a Nuclear Submarine, such as the *George Washington*, a fleet ballistic-missile submarine, is shown in pictures taken aboard the *Nautilus, Skate,* and *Seawolf.*

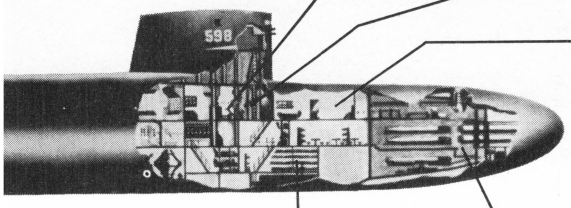
HOW SUBMARINES DEVELOPED



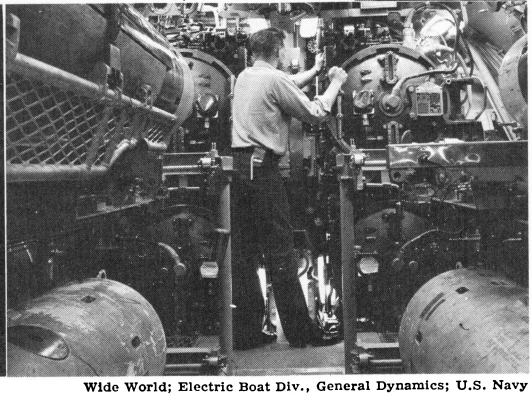
In the Conning Tower, the gunnery officer searches for potential targets on the surface with the periscope.

Diving Control Center gauges air and water pressure in the submersion tanks that give the submarine buoyancy.





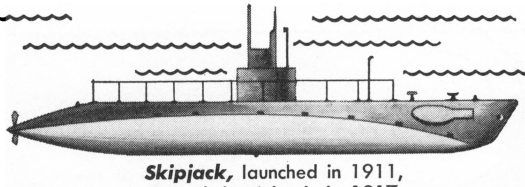
Crew's Quarters may seem cramped, but they are more comfortable than similar quarters on other submarines.



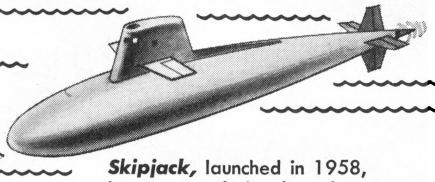
Officers' Wardroom shows some of the comforts of sailing aboard a nuclear submarine. More than 100 officers and men live in fairly close quarters.

Torpedo Tubes, which hold torpedoes ready for firing, are checked by a crew member. Other torpedoes lie in racks behind him. Many new submarines carry ballistic missiles instead of torpedoes.

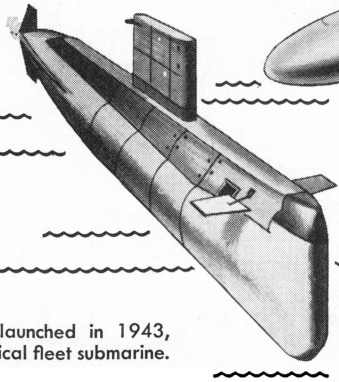
Wide World; Electric Boat Div., General Dynamics; U.S. Navy

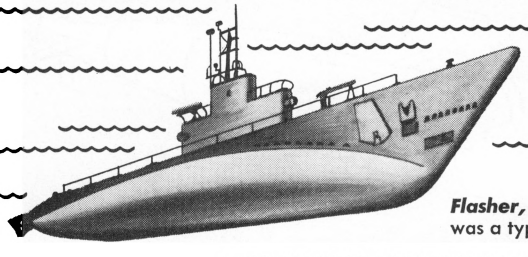


Skipjack, launched in 1911, crossed the Atlantic in 1917.



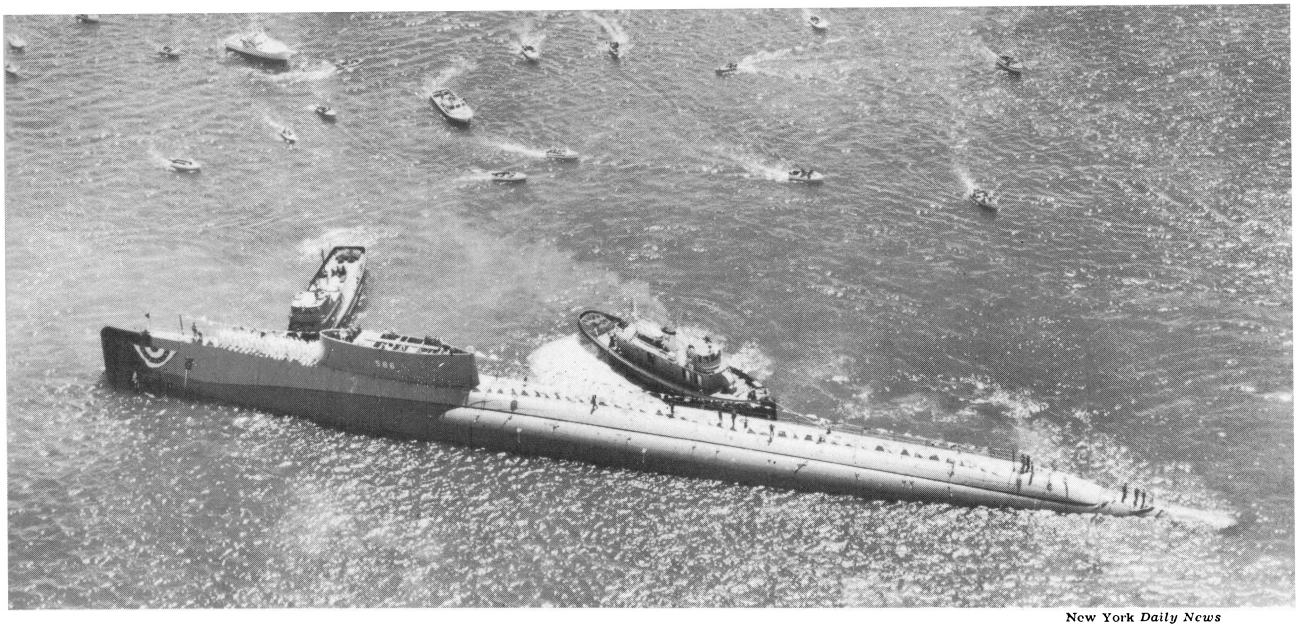
Skipjack, launched in 1958, has a new design based on that of the *Holland,* the first navy submarine.





Flasher, launched in 1943, was a typical fleet submarine.

Nautilus began operating with nuclear power in 1955.



New York *Daily News*

The Nuclear-Powered *Triton* Was the First Submarine to Go Around the World Without Surfacing.

the main ballast tanks. Back on the surface, the submarine will continue to float as long as air pressure keeps water out of the tanks.

Life Aboard a Submarine

Life on a submarine is not a pleasure cruise. Even on nuclear-powered ships, there is little room for living quarters. When they must conserve oxygen, the men lie on their bunks, sleeping, reading, or playing cards, and moving as little as possible.

To offset these unpleasant factors, submarine sailors are given the finest possible food, much time off, and extra pay. Each submarine equipped with Polaris missiles has a *blue* crew and a *gold* crew of over 100 men each. They take turns on the ship so it can stay at sea almost all the time. All men on submarines are volunteers. They develop a feeling for their ship and crew that enables them to take many difficulties in stride.

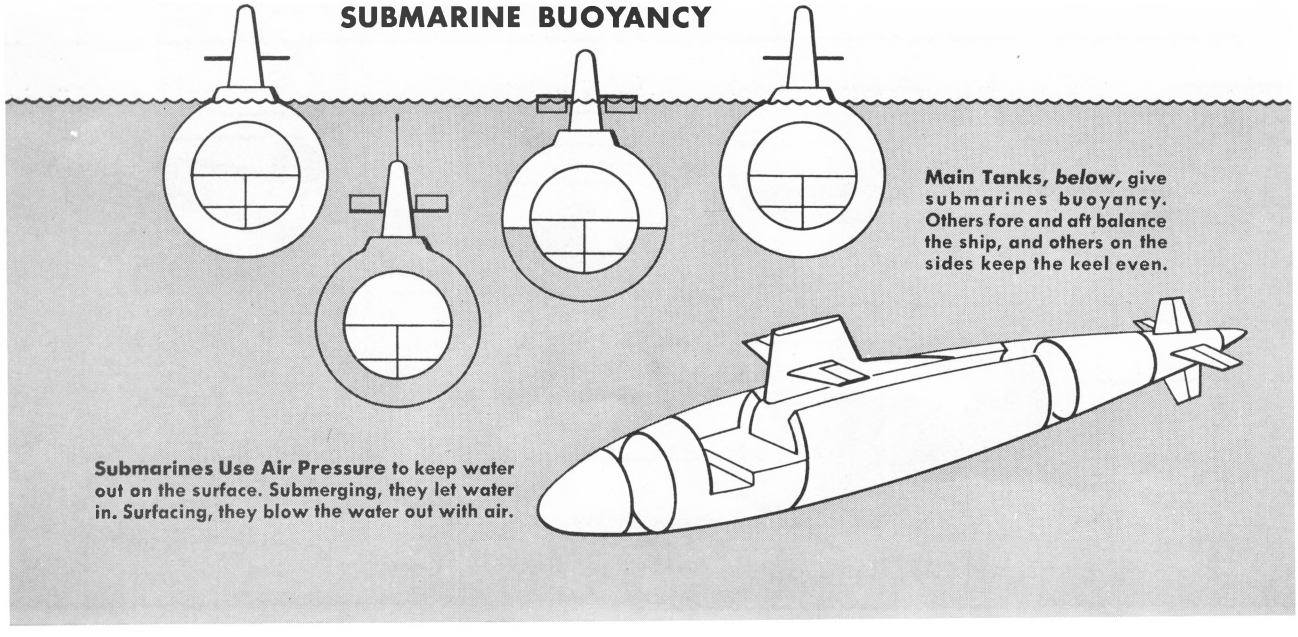
In wartime, submarine duty is extremely dangerous, as well as hard. The crew keeps constant watch on the movements of other ships, and listens with sonar for the approach of potential enemies.

Development of the Submarine

Early Efforts. The first submarine was a leather-covered rowboat which Cornelius van Drebbel, a Dutch scientist, demonstrated in England about 1620. But little was done with submarines until the Revolutionary War in America. David Bushnell (1742?-1824) built the *Turtle*, a one-man ship that submerged when he filled ballast tanks with water. The *Turtle* made an unsuccessful attack on a British man-of-war in New York harbor —the first recorded submarine attack on a warship.

Robert Fulton built the *Nautilus*, a copper-covered submarine 21 feet (6 meters) long, in 1800. Fulton tried to interest the French in his craft. They were not impressed, even though Fulton blew up a sloop in a demonstration.

During the Civil War, the Confederate *Hunley* made the world's first successful attack on a warship. In 1864,



the *Hunley* rammed the Federal warship *Housatonic* in Charleston harbor. A torpedo on the *Hunley's* spar exploded, sinking both ships. Experiments continued after the war, spurred by the development of a self-propelled torpedo in the late 1860's. Two designers concentrated on submarines. Simon Lake (1866-1945) worked out the idea of submerging by negative buoyancy, which is used today. Lake also built wheels on one submarine for travel on the ocean floor. John P. Holland experimented in other directions, and won a U.S. Navy contract in the late 1890's.

Holland's submarine, launched in 1898, was commissioned the U.S.S. *Holland* in 1900—the navy's first submarine. It was 53 feet (16 meters) long and displaced 75 long tons (76 metric tons). It used a gasoline engine on the surface and an electric motor when submerged, and could speed at 7 knots on the surface. It had a torpedo tube, but no periscope.

During World War I, German submarines, called *Unterseebooten* or U-boats, quickly demonstrated the importance of undersea warfare. One U-boat sank three British cruisers in one engagement. The Germans soon began enforcing their blockade of Great Britain with U-boat attacks on merchant ships and passenger liners. Public feeling ran high against the Germans when they torpedoed the British *Lusitania* in the Atlantic in May, 1915. The United States entered the war partly because of Germany's unrestricted submarine warfare.

In World War II, all the warring nations used submarine fleets. The Germans again used submarines to try to enforce their naval blockade of Great Britain. They developed *wolf packs*, teams of from 2 to 40 submarines operating together, to attack convoys in the North Atlantic Ocean. Snorkel-equipped German submarines became a menace. The Allied nations developed new convoy techniques to meet the submarine challenge. They also speeded the construction of *subchasers*, or fast escort vessels. The development of radar and sonar provided new ways of locating submarines.

The Japanese used midget submarines and extra-large submarines. The United States Navy worked on fleet submarines, larger and more powerful than earlier American undersea craft. Some American submarines made history with their exploits. The U.S.S. *Barb* is generally credited with firing the most valuable six-torpedo salvo in submarine history. The torpedoes sank a Japanese escort carrier and a tanker. The *Barb* later became the first submarine to fire rockets at targets ashore.

New Developments. After World War II, designers worked on craft that could move faster and stay under water longer. The British launched a submarine powered with hydrogen peroxide, the *Explorer*, in 1954.

In 1954, the United States launched the world's first nuclear-powered warship, the *Nautilus*. The ship, a joint project of the navy and the Atomic Energy Commission, began operating in 1955. The *Nautilus* made history by sailing under the North Pole in 1958. The navy tested a new fish-shaped hull in the *Albacore*, and later adopted it for the nuclear submarine *Skipjack*.

In 1960, the *Triton*, powered by twin nuclear plants, traveled around the world under water. It covered 41,500 miles (66,790 kilometers) in 84 days. The nuclear submarine *Seadragon* made the first underwater trip through the Northwest Passage the same year. The *Seadragon* traveled from the Atlantic Ocean to the Pacific Ocean through the Canadian Archipelago.

During the 1960's, the U.S. Navy developed and put on duty several classes of nuclear-powered submarines. These classes include the *Lafayette*, *Ethan Allen*, *George Washington*, and *Thresher*. The United States planned for a fleet of more than 100 nuclear submarines by the early 1970's. Over 40 of these would carry *Polaris* ballistic missiles, which can be fired from under water.

The United States has more nuclear-powered submarines than any other nation, but Russia has the largest submarine fleet. By the early 1970's, Russia had about 420 submarines of all types, compared to about 160 for the United States. RAYMOND V. B. BLACKMAN

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World War II (The Battle of the Atlantic)

SUBMARINO. See DIVING, UNDERWATER (Diving in Oceanographic Submarines).

SUBPOENA, *suh PEE nuh*, or SUBPENA, is a legal notice to appear as a witness and give testimony in court. The name comes from two Latin words, *sub*, which means *under*, and *poena*, which means *penalty*. A person who receives a subpoena must obey it *under penalty* of being held in contempt of court (see CONTEMPT). The *subpoena duces tecum* (Latin for *bring with you under penalty*) requires a person to bring into court specified things, such as papers, books, financial records, or other documents. See also WITNESS. THOMAS A. COWAN

SUBSET. See SET THEORY.

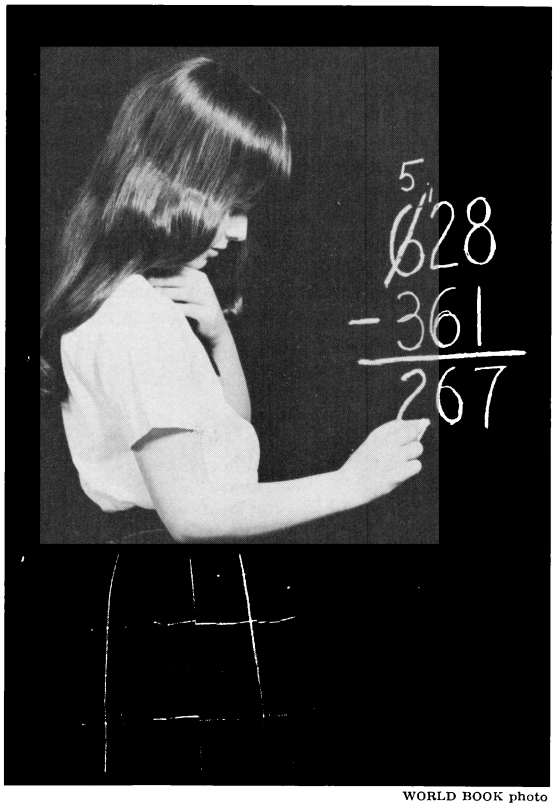
SUBSIDY, *SUB suh dee*, is a money payment or other form of aid that the government gives to a person or organization. Its purpose is to encourage some needed activity by furnishing funds, free land, or legal rights that might otherwise be lacking.

In the 1800's, the United States government gave large tracts of land to the railroads on the condition that they would build lines across the continent. Altogether, the railroads received about 160,000,000 acres (64,700,000 hectares) of land in this way. The government also granted subsidies to telegraph and cable companies. In the 1920's, it granted subsidies to ship companies. It gave them generous mail-carrying contracts and allowed them to buy government-owned ships at a fraction of their actual cost. Government air-mail contracts have also aided the airlines since the 1920's.

Federal, state, and local governments award subsidies for a variety of activities. The federal government gives subsidies to farmers in an effort to control farm production and prices. Taxes on goods imported into the United States are indirect subsidies to U.S. manufacturers who make the same kind of goods. Subsidies also help finance many schools. Subsidies are sometimes improperly awarded to gain the political support of those receiving the aid. ROBERT D. PATTON

See also AGRICULTURE (Surpluses); EDUCATION; TARIFF (Kinds of Tariffs).

SUBSOIL. See SOIL (Depth).



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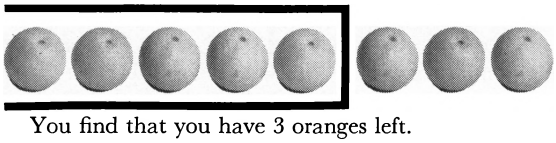
SUBTRACTION is a way of taking away a number of things from a larger number. You take them away to find how many things are left. Only *like things* can be subtracted. That is, you cannot subtract apples from pencils.

Suppose you have a set of 8 oranges.

Suppose you want to take away a set of 5 oranges.

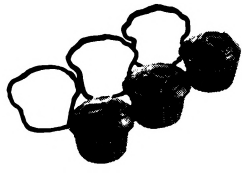


You find that you have 3 oranges left.

Learning To Subtract

A question such as "3 from 6 is how many?" is a subtraction problem. To find out how many things are left in a subtraction problem, you can *count* or find the answer by *thinking*.

Subtraction by Counting. Here are two groups of chocolate cupcakes.



How many cupcakes are there in the first group? Count them. There are 6 cupcakes in the first group. Mary took 3 cupcakes from the second group. How many cupcakes are left in the second group? Count them. There are 3 cupcakes left. You counted to find how many cupcakes are left if you take 3 from 6. You discovered that 3 taken from 6 leaves 3.

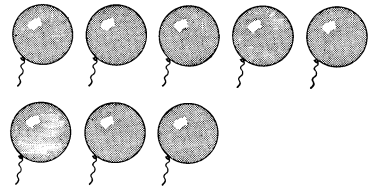
Subtraction by Thinking. Tommy has 5 pennies.

He wants to spend 2 pennies for a pencil. How many pennies will Tommy have left? Cover 2 pennies in the picture. You should be able to tell how many pennies are left by just looking at the picture, without counting. You should learn to *think* "2 from 5 leaves 3." This article will show you the facts you need to know to subtract by thinking. Thinking the answer is a quicker way of subtracting than counting.

You can learn to think the answer to a subtraction problem from what you know about addition. For example, you know that 3 and 2 are 5. This means that if you take 2 from 5, you have 3. You can practice by writing the addition and subtraction facts in groups of four.

3 and 4 are 7	4 from 7 leaves 3
4 and 3 are 7	3 from 7 leaves 4

Subtraction Questions. Subtraction tells you how many things are left when you take away one set of things from another. It also lets you *compare* two sets of things. Suppose Mary has 5 balloons and Sue has 3 balloons.



To compare the two sets of balloons, you must find the *difference* between the two sets. You can find the difference by subtracting. When you subtract 3 from 5, you

SUBTRACTION TERMS

Borrow in subtraction means to change a 10 in the minuend into 1's, to change a 100 into 10's, or to change a 1,000 into 100's, and so on.

Difference. In $12-7=5$, the number 5 is the difference. It means that 12 and 7 are being compared.

Minuend. In $12-7=5$, the number 12 is the minuend.

Minus in subtraction means *less* or *take away*. For example, 12 *minus* 7 is 5.

Remainder. In $12-7=5$, the number 5 is the remainder. It is the answer to the subtraction problem.

Subtraction Fact is a basic statement in subtraction. For example, $16-9=7$ and $4-3=1$ are two subtraction facts.

Subtrahend. In $12-7=5$, the number taken away (7) is the subtrahend.

discover that the difference between the two sets is 2 balloons, or 2.

You can also use subtraction to find out how many more things are needed. Suppose John needs 12 pennies. He has 5 pennies. How many more pennies does he need?

When you subtract 5 from 12, you discover that John needs 7 more pennies to make 12.

Subtraction can tell you (1) how many things are left, (2) what the difference is, and (3) how many more things are needed.

Writing Subtraction. It is best to write your subtraction problems and their answers. This gives you a record of your thinking.

You can make a record with pictures.

The picture shows that 3 taken from 5 leaves 2.

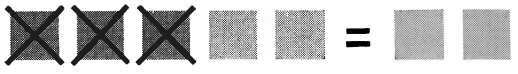
You can write this in numbers and words.

3 from 5 leaves 2

But you must learn to write with numbers and signs.

$$5-3=2$$

The − sign means to subtract or take away. So 5−3 means "3 taken from 5." We call the − sign the *minus sign*, and read 5−3 as "5 *minus* 3." The = sign means that the sets on one side of the = sign are *equal* to the sets on the other side. Here is how it works:



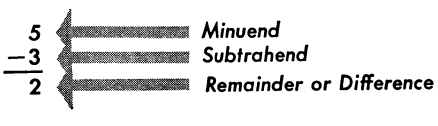
5−3 = 2

There is another way to use numerals and signs.

$$\begin{array}{r} 5 \\ -3 \\ \hline 2 \end{array}$$

Most people use this form when working out problems in subtraction.

Each part of a subtraction problem has a name. When we are subtracting to find out how many things are left, we call the answer the *remainder*. When we are subtracting to compare two groups or to find how many more things are needed, we call the answer the *difference*. We call the number being taken away or subtracted the *subtrahend*. The number from which the subtrahend is taken is called the *minuend*.



Subtraction Facts. By subtracting one group from another, you discover that 8−5=3, 6−3=3, and 12−5=7. We call these *subtraction facts*.

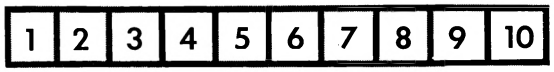
Each subtraction fact consists of a minuend, a subtrahend, and a remainder, or difference. There are 81 subtraction facts. You can discover each one of them for yourself by counting and taking away one set of things from another. For example, you can practice by crossing off squares as you have seen crossing off done in an earlier example.

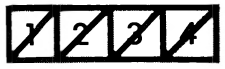
The 81 Subtraction Facts

2	3	4	5	6	7	8	9	10
−1	−1	−1	−1	−1	−1	−1	−1	−1
1	2	3	4	5	6	7	8	9
3	4	5	6	7	8	9	10	11
−2	−2	−2	−2	−2	−2	−2	−2	−2
1	2	3	4	5	6	7	8	9
4	5	6	7	8	9	10	11	12
−3	−3	−3	−3	−3	−3	−3	−3	−3
1	2	3	4	5	6	7	8	9
5	6	7	8	9	10	11	12	13
−4	−4	−4	−4	−4	−4	−4	−4	−4
1	2	3	4	5	6	7	8	9
6	7	8	9	10	11	12	13	14
−5	−5	−5	−5	−5	−5	−5	−5	−5
1	2	3	4	5	6	7	8	9
7	8	9	10	11	12	13	14	15
−6	−6	−6	−6	−6	−6	−6	−6	−6
1	2	3	4	5	6	7	8	9
8	9	10	11	12	13	14	15	16
−7	−7	−7	−7	−7	−7	−7	−7	−7
1	2	3	4	5	6	7	8	9
9	10	11	12	13	14	15	16	17
−8	−8	−8	−8	−8	−8	−8	−8	−8
1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18
−9	−9	−9	−9	−9	−9	−9	−9	−9
1	2	3	4	5	6	7	8	9

It is best to learn the subtraction facts so that you can recall them without stopping to work them out. You can use them to solve problems right away.

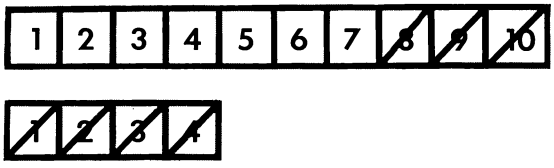
To learn the harder facts, it is sometimes useful to *regroup*. For example, many persons find it easier to subtract numbers from 10. Suppose you wanted to solve the problem 14−7. You know that 14 is the same as one 10 and four 1's. So you could regroup it like this.





SUBTRACTION

First, you can take away 4. You know that $7-4=3$, so you must still take away 3. Subtracting $10-3$ is easy.



You can see that $10-3=7$. So $14-7=7$.

You can probably invent other ways to help you learn the subtraction facts.

Subtracting Larger Numbers

Subtracting larger numbers is not difficult, if you know the subtraction facts and understand the number system.

Subtracting 10's and 100's. Suppose you have 5 dimes. This is the same as 50¢. Suppose you want to spend 3 dimes on a book. This is the same as 30¢. How much money will you have left? The problem is 5 dimes − 3 dimes or 50¢ − 30¢. You can find the answer by counting.

You can also find the answer by using the subtraction facts and thinking.

5 dimes	50¢
−3 dimes	−30¢
2 dimes	20¢

If you know that $5-3=2$, you can see that 3 dimes taken from 5 dimes leaves 2 dimes. A dime is 10¢, so you can see that $50-30=20$. The subtraction fact $5-3=2$ helps you find the answer. *You subtract 10's the same way that you subtract 1's. But you must write the remainder in the 10's place.* And you must remember to write in a zero to show that the remainder is 10's, not 1's.

Subtracting 100's is done in the same way. Suppose you had to subtract 3 dollars from 5 dollars.

5 dollars	500¢	500
−3 dollars	−300¢	−300
2 dollars	200¢	200

You subtract 100's (and 1,000's and so on) the same way that you subtract 1's and 10's. Once again, you can see how the subtraction fact helps you find the answer to the subtraction example.

Subtracting 10's and 1's. Tom had 45 tickets to sell. He sold 23 of them. How many tickets should he have left? That is, what is $45-23$? We call numbers such as 45 and 23 *two-place* numbers, because 45 has two places, four 10's and five 1's; and 23 has two places, two 10's and three 1's.

4 tens and 5 ones	45
−2 tens and 3 ones	−23
2 tens and 2 ones	22

To subtract one two-place number from another, you begin by subtracting the 1's: $5-3=2$. Write the 2 in the 1's place in the remainder.

$$\begin{array}{r} 45 \\ -23 \\ \hline 2 \end{array}$$

Next, subtract the 10's: $4-2=2$. Remember that the $4-2$ stands for 10's, not 1's. Write the 2 in the 10's place in the remainder.

$$\begin{array}{r} 45 \\ -23 \\ \hline 22 \end{array}$$

So Tom should have 22 tickets left.

Here is an example of subtracting *three-place numbers.*

$$\begin{array}{r} 647 \\ -123 \\ \hline 524 \end{array}$$

First, subtract the 1's: $7-3=4$. Write the 4 in the 1's place of the remainder. Next, subtract the 10's: $4-2=2$. Write the 2 in the 10's place in the remainder. Next, subtract the 100's: $6-1=5$. Write the 5 in the 100's place in the answer. Subtracting two- and three-place numbers is easy, but you must remember two things. You must subtract the 1's, 10's, 100's, 1,000's, and so on, *in that order.* Always begin at the right—in the 1's place—and work to the left. Second, you must write your work carefully, so that the numbers of the remainders are in the proper places.

How to Borrow. When you subtract larger numbers, you often cannot solve a problem unless you know how to *borrow.* For instance, look at the example $62-27$. How can you subtract seven 1's from two 1's? Borrowing helps solve this kind of example.

To understand borrowing, you must follow an example step by step. In the example $62-27$, the first step is to write the numbers as 10's and 1's.

62	6 tens 2 ones
−27	−2 tens 7 ones

You cannot subtract seven 1's from two 1's. *But you can take one of the 10's in the minuend and change it into 1's.* Now you can solve the problem.

6 tens 2 ones	5 tens 10+2 ones	5 tens 12 ones
−2 tens 7 ones	−2 tens 7 ones	−2 tens 7 ones
		3 tens 5 ones

So $62-27=35$. There were too many 1's in the subtrahend to subtract. You "borrowed," or changed a 10 from the 10's part of the minuend into the 1's. This is what borrowing means. You can also borrow 100's, 1,000's, and so on, in solving problems.

You do not have to write out a problem every time you borrow. You can *think* the steps and write in little numbers as a guide. Here is the same example:

$$\begin{array}{r} 62 \\ -27 \\ \hline \end{array}$$

First, you study the example. "I cannot take 7 from 2," you think, "so I must change a 10 to 1's." You draw a

line through the 6 in the minuend and write a 5 above it. This means that there are now five 10's in the 10's place instead of six. Next, you write a little 1 just above and to the left of the 2. This means that there are now twelve 1's, instead of two.

$$\begin{array}{r} {}^{5}\not{6}\,{}^{1}\not{2} \\ -27 \\ \hline \end{array}$$

Now you can do the subtraction. "Seven 1's from twelve 1's leave 5," you think, and write a 5 in the 1's place of the remainder. "Two 10's from five 10's leave 3," you think, and write a 3 in the 10's place of the remainder. This completes the example.

$$\begin{array}{r} {}^{5}\not{6}\,{}^{1}\not{2} \\ -27 \\ \hline 35 \end{array}$$

The same method of "borrowing" a 10 can be used for 100's and 1,000's.

$$\begin{array}{r} 628 \\ -361 \\ \hline 7 \end{array}$$

First, you subtract one 1 from eight 1's, and write a 7 in the 1's place of the remainder. But you see that you cannot subtract six 10's from two 10's. You must borrow a 100, or ten 10's, from the six 100's in the minuend.

$$\begin{array}{r} {}^{5}\not{6}28 \\ -361 \\ \hline 7 \end{array}$$

You draw a line through the 6 in the minuend and write a 5 above it. This means that there are now five 100's in the 100's place, instead of six. Next, you write in a little 1 just above and to the left of the 2. This means that there are now twelve 10's, instead of two. Now you can finish the subtraction. Six 10's from twelve 10's leaves six. You write a 6 in the 10's place of the remainder. Three 100's from five 100's leaves two. You write a 2 in the 100's place of the remainder.

$$\begin{array}{r} {}^{5}\not{6}28 \\ -361 \\ \hline 267 \end{array}$$

You use the same method for 1,000's. You borrow a 1,000 just as you borrowed a 10 or a 100.

Checking Subtraction

You should always check your work in subtraction to make sure that you have done it correctly.

Checking by Subtraction. One way to check a subtraction problem is to subtract the remainder from the minuend.

Problem		Check	
628	Minuend	628	Minuend
−361	Subtrahend	−267	Remainder
267	Remainder	361	

The new remainder should be the same as the old subtrahend. This checks your work.

Checking by Addition. A good way to check subtraction problems is by addition, because addition is the opposite of subtraction. You add the subtrahend and the remainder.

Problem		Check	
628	Minuend	361	Subtrahend
−361	Subtrahend	+267	Remainder
267	Remainder	628	

The sum of the addition should be the same as the old minuend in the subtraction problem.

Estimating helps you know if your answer is reasonable. Try to estimate the answer *before* you work the problem. Here is an example:

$$\begin{array}{r} 476 \\ -254 \\ \hline 222 \end{array}$$

ESTIMATING

(Think)
476 is about 475.
254 is about 250.
475 is 400 and 75.
250 is 200 and 50.
75 − 50 is 25.
400 − 200 is 200.
The answer should be about 225.

This is almost the exact answer. You can estimate in larger numbers. For example, 476 is about 500, and 254 is about 250. Subtracting 500 − 250 gives you 250. This gives you a good idea of what the answer should be. Estimating the answer before you work a problem will save you time if you make a mistake, because you know about what the answer should be.

Subtraction Rules To Remember

Here are six rules that will help you solve subtraction problems.

1. Remember what subtraction means. You can find the answers to subtraction problems by counting. But it is quicker and easier to *think* the answers.
2. Learning the 81 subtraction facts will help you think the answers to subtraction problems quickly.
3. Subtraction is the opposite of addition. Because of this, addition will help you learn the subtraction facts and check problems.
4. The subtraction facts help you subtract larger numbers to solve problems.
5. You can only subtract quantities of the same kind. That is, you must subtract 1's from 1's and 10's from 10's.
6. Subtraction answers three kinds of questions: how many are left, what is the difference, and how many more are needed.

Other Ways To Subtract

There are several ways of thinking out a subtraction problem. The method we have used is called the "*take-away-borrow*" *method.* Here is another example:

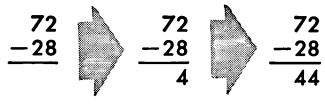
$$\begin{array}{r} 72 \\ -28 \\ \hline \end{array} \quad \Rightarrow \quad \begin{array}{r} {}^{6}\not{7}\,{}^{1}\not{2} \\ -28 \\ \hline 4 \end{array} \quad \Rightarrow \quad \begin{array}{r} {}^{6}\not{7}\,{}^{1}\not{2} \\ -28 \\ \hline 44 \end{array}$$

First, you see that you cannot take eight 1's from two 1's. You borrow a 10, making the minuend six 10's and twelve 1's. Then you subtract eight 1's from twelve

SUBTRACTION

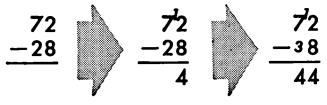
1's: 12−8=4. You write the 4 in the 1's place in the answer. Next you subtract two 10's from six 10's: 6−2=4. You write the 4 in the 10's place in the answer.

Another method is called the "*addition-borrow*" *method.*



The numbers are the same as in the "take-away-borrow" method, but the *thinking* is different. You see that you cannot take eight 1's from two 1's, and borrow a 10. Instead of subtracting eight 1's from twelve 1's, you think "what *added* to 8 makes 12?" You know that 8+4=12, so you write the 4 in the 1's place in the answer. Instead of subtracting two 10's from six 10's, you think "what *added* to 2 makes 6?" You know that 2+4=6, so you write the 4 in the 10's place in the answer.

A third method is called the "*addition-carry*" *method.*



First, you see that you cannot take eight 1's from two 1's. Instead of borrowing, you add ten 1's to the two 1's: 2+10=12. Next, you think "what *added* to 8 makes 12?" You know that 8+4=12, so you write the 4 in the 1's place in the answer. Now you think "I added a 10 to the 1's, so I must subtract a 10 from the 10's." To do this, you change the two 10's in the subtrahend to three 10's. You think "what *added* to 3 makes 7?" You know that 3+4=7, so you write the 4 in the 10's place in the answer.

Fun with Subtraction

Many games that can be played with the addition, multiplication, and division facts can be changed a little for the subtraction facts.

To play a game called *More or Less*, make a pack of 36 cards. Write the numbers from 1 to 18 separately on two sets of cards. This means that there are two cards for each number. Shuffle the cards and place the pile face down. The leader of the game takes the first card and holds it up for the players to see. Suppose it is 14. The first player takes a card from the pile and shows it. Suppose it is 6. He compares it with the 14 card and says "It is less." Then he must tell how much less. In this case, he would say "It is 8 less than 14." He must find the answer by thinking the subtraction. Suppose the next player turns up 17. He compares it with the first card. He must say "It is more. It is 3 more than 14." If a player gives the wrong answer, he is out of the game. When you have gone through the cards once, you can mix them up and go through the game again with new numbers.

CHARLOTTE JUNGE

Related Articles in WORLD BOOK include:

Addition, Algebra (Subtraction), Arithmetic, Decimal, Division, Fraction, Mathematics, Multiplication, Numeral System

Outline

I. Learning To Subtract
- A. Subtraction by Counting
- B. Subtraction by Thinking
- C. Subtraction Questions
- D. Writing Subtraction
- E. Subtraction Facts

II. Subtracting Larger Numbers
- A. Subtracting 10's and 100's
- B. Subtracting 10's and 1's
- C. How to Borrow

III. Checking Subtraction
- A. Checking by Subtraction
- B. Checking by Addition
- C. Estimating

IV. Subtraction Rules To Remember

V. Other Ways To Subtract

VI. Fun with Subtraction

PRACTICE SUBTRACTION EXAMPLES

1. 8 − 5 =	4. 18 − 5 =	7. 15 − 9 =	10. 7 − 5 =	13. 9 − 3 =
2. 7 − 4 =	5. 17 − 4 =	8. 15 − 7 =	11. 7 − 2 =	14. 14 − 8 =
3. 8 − 6 =	6. 18 − 6 =	9. 15 − 6 =	12. 9 − 6 =	15. 14 − 6 =

16.	5 −2	21.	120 −30	26.	90 −30	31.	67 −23	36.	83 −48	41.	923 −465
17.	50 −20	22.	8 −4	27.	7 −4	32.	628 −115	37.	65 −39	42.	307 −186
18.	8 −3	23.	80 −40	28.	70 −40	33.	843 −531	38.	625 −241	43.	503 −280
19.	80 −30	24.	6 −4	29.	84 −22	34.	6725 −3513	39.	729 −381	44.	700 −265
20.	12 −3	25.	9 −3	30.	95 −34	35.	52 −26	40.	90 −36	45.	900 −189

ANSWERS TO THE PRACTICE EXAMPLES

1. 3	6. 12	11. 5	16. 3	21. 90	26. 60	31. 44	36. 35	41. 458
2. 3	7. 6	12. 3	17. 30	22. 4	27. 3	32. 513	37. 26	42. 121
3. 2	8. 8	13. 6	18. 5	23. 40	28. 30	33. 312	38. 384	43. 223
4. 13	9. 9	14. 6	19. 50	24. 2	29. 62	34. 3,212	39. 348	44. 435
5. 13	10. 2	15. 8	20. 9	25. 6	30. 61	35. 26	40. 54	45. 711

SUBURB is a community outside or near a large central city. Since the end of World War II in 1945, suburbs in the United States have grown much faster—both in area and population—than central cities or small towns. In the early 1970's, more Americans lived in suburbs than in central cities. Families with school-age children make up the great majority of suburban residents.

People live in suburbs for various reasons. Many families seek a home, a yard, and freedom from overcrowded, declining city neighborhoods. Others believe their children will have better educational opportunities in the suburbs. Some people move to escape the noise, air pollution, and social conflicts of urban areas.

Most suburban families live in single-family houses, though the number of apartment buildings is increasing. Many suburbs are made up of residents with similar incomes, nationalities, and religions. Black Americans at all income levels find it difficult to obtain suburban homes because of discrimination in the sale and rental of housing.

Many suburban residents travel to the central city to work and for recreational and cultural activities. But there are industrial suburbs as well as primarily residential ones. Many suburban factories, offices, and shopping centers appeared during the 1960's. Most suburbs have their own governments, with a mayor or city manager, a council, and such municipal departments as the police. Other suburbs are governed directly by county officials.

Extensive suburban growth in the United States began in the late 1800's with the development of railroads. People could live in the "country" and ride the train to their jobs in the city. The move to the suburbs has also been helped by federal loans to people who want to buy new homes. During the 1950's and 1960's, general prosperity increased the move to suburbs by middle-income groups. More and more families became able to buy one or two automobiles. Cars are necessary for most suburbanites because of the distances they must travel to work or to shop. Many suburban commuters face the problem of driving on jammed expressways.

The rapid growth of suburbs has created problems for local governments. Many suburbs have difficulty raising money for such services as water, police and fire protection, and especially education. The large number of children in suburbs has made it necessary to provide extensive new educational facilities. Much conflict in suburbs involves the quality of schools and the taxes needed to pay for them. It also involves the handling of controversial social issues. J. David Greenstone

See also City; City Government; Local Government; Metropolitan Area.

SUBVERSIVE ACTIVITY. See Un-American Activities Committee.

SUBWAY is an underground railway. In New York City, London, Paris, and Moscow, the subway system is a great, complicated network of tunnels. London was the first city to have a subway, and now has seven systems that provide quick and cheap transportation to all parts of the city and suburbs. London subways are called *tubes*. Some are so far underground that passengers go down on elevators. The first subway built in London was operated by steam locomotives, and opened in 1863. The first deep-level tube was opened in 1890, and had electric locomotives. All subways since that time have been operated by electricity. Other major cities, and the years their subways were opened, include: Madrid (1919); Barcelona (1924); Sydney (1926); Tokyo (1927); Buenos Aires (1928); Moscow (1935); Toronto (1954); Milan (1964); Montreal (1966); and Mexico City (1969).

Several large cities in the United States have subway systems. Boston was the first American city to have a subway, opening its line of $1\frac{1}{2}$ miles (2.4 kilometers) in 1897. The subway in New York City is the largest in the world, and is probably the best example of passenger-subway construction. This system is so large that a person can travel from the New Jersey shore, under the city, beneath two rivers into Long Island, without once seeing daylight. The first sections of New York's Subway were opened in 1904. Subways also operate in Chicago, Philadelphia, and San Francisco.

There are two types of subways. One is called the *open cut*. The construction crew tears out the streets, and builds the subways in deep ditches. If two lines are going to cross, the crew digs one roadbed deeper than the other. They then lay pavement over the subway. The other form of subway, called a *tube*, is constructed by boring through the earth at the desired depth without disturbing the surface. This type of construction is for one or two tracks. The tunnels of an open-cut subway are rectangular. The tunnels of the other subway are usually circular or semicircular. New York City's subway is rectangular and London's is semicircular.

Subways must be built so that ventilation is good. Stale air is carried off through vents. Fresh air may be brought into the system by means of fans.

The cost of construction of a subway is very high. The New York City system cost from $2 million to $3 million per mile ($1.3 million to $1.9 million per kilometer). Franklin M. Reck

See also Electric Railroad; New York City (Transportation); Tunnel.

Chicago's Subway runs through a semicircular tunnel over much of its route. This station is one of 20 along 10 miles (16 kilometers) of tunnel.

Chicago Transit Authority

SUCCESSION, PRESIDENTIAL. See PRESIDENTIAL SUCCESSION.

SUCCESSION WARS. Wars growing out of disputes over who should *succeed to* (inherit) a throne are called *succession wars*. Four important conflicts in European history are known by this name. They are the War of the Spanish Succession, the War of the Polish Succession, the War of the Austrian Succession, and the War of the Bavarian Succession.

The War of the Spanish Succession began in 1701 and lasted until 1714. Its American phase was known as Queen Anne's War (1702-1713).

Charles II, king of Spain, had no children, and all Europe was interested in the question of who would be his successor. The laws governing succession were so involved, and the claims of the different heirs were so conflicting, that it is almost impossible to say who rightfully should have worn the Spanish crown.

When King Charles II died in Spain on November 1, 1700, he left a will that gave the crown to the French prince, Philip of Anjou. Philip's grandfather, Louis XIV of France, then proclaimed him king of Spain, and declared that the Pyrenees no longer separated the two kingdoms. Since French power was already feared in Europe, other countries were alarmed at the prospect that France might annex the Spanish Empire.

Almost immediately the Grand Alliance was formed by England, The Netherlands, Prussia, Austria, and most of the other states of the Holy Roman Empire. This alliance sought to prevent Philip of Anjou from becoming king of Spain, and to put the Archduke Charles of Austria on the throne instead. War broke out between France and the Grand Alliance. The French were defeated decisively in the battles of Blenheim, Ramillies, Oudenarde, and Malplaquet. The English general, the Duke of Marlborough, and the imperial general, Prince Eugene of Savoy, commanded the forces of the Grand Alliance.

In 1711, Joseph I, the Holy Roman Emperor and ruler of Austria, died. He was succeeded by his brother, the Archduke Charles, who was the allies' candidate for the Spanish throne. It then became clear that the balance of power would be even more seriously threatened if Charles got Spain as well as Austria than it would be if Philip became king of Spain. Charles as ruler of Austria would be placed in a position where he would control Spain as well as the Holy Roman Empire.

In 1713, Louis XIV used skillful diplomacy to bring about the Peace of Utrecht, under which he obtained fairly favorable terms. His grandson, Philip, was recognized as king of Spain on the condition that Spain and France would never be united. Charles refused to sign the Treaty of Utrecht and did not make peace until a year later. Then he found it necessary to give way and sign the Treaty of Rastatt, which was almost exactly the same as the Peace of Utrecht.

The War of the Polish Succession (1733-1735) was caused when Polish nobles elected Stanislas Leszczyński, father-in-law of Louis XV of France, as king of Poland. Russia and Austria forced the Poles to accept the Elector Augustus of Saxony as king. War followed between France, aided by Spain, and Russia, aided by Austria. The outcome of the war was a damaging blow to French prestige. Augustus of Saxony remained King of Poland.

The War of the Austrian Succession (1740-1748) was known in America as King George's War. It was caused by the death of the Austrian ruler Charles VI, who had no sons and left his dominions to his daughter Maria Theresa. The great powers of Europe had guaranteed that a daughter of Charles could succeed him by the terms of the Pragmatic Sanction. But they broke their words and tried to take Maria Theresa's lands. See PRAGMATIC SANCTION.

The first to attack Maria Theresa was Frederick the Great, king of Prussia, who conquered the province of Silesia. In 1741 he strengthened his hold upon the territory by an overwhelming victory at Mollwitz. France, Spain, Bavaria, Saxony, Sardinia, and Poland joined Prussia, and for a time Maria Theresa was threatened with the loss of her dominions. But she contrived to save her crown and most of her lands by her own great courage and vigorous leadership. Her appeal to the Hungarians won her the powerful support of this chivalrous people. Maria Theresa was further aided by an alliance with the great maritime powers, England and Holland, which crushed the power of France at sea. She separated Frederick the Great from his allies by giving him Silesia. The Treaty of Aix-la-Chapelle, signed in 1748, finally ended the war.

The War of the Bavarian Succession (1778-1779) was a short quarrel between Prussia and Austria over the succession to the throne of Bavaria and the disposition of some Bavarian territory. In 1777, the Elector of Bavaria, Maximilian Joseph, died and left no direct heirs. Austria then attempted to control the affairs of Bavaria and to dictate the succession. This aroused the jealousy of Frederick the Great. Armed forces from Prussia and Austria invaded Bavaria, and war seemed inevitable.

But neither Austria nor Prussia was anxious for war. No battles were fought, and the war is often called "the potato war." Hungry soldiers spent their time searching for food in the fields. Catherine II of Russia mediated peace. In the Treaty of Teschen, signed in 1779, both Austria and Prussia were satisfied with certain territorial gains. ROBERT G. L. WAITE

Related Articles in WORLD BOOK include:
Aix-la-Chapelle, Treaties of
Blenheim, Battle of
Charles (VI) of the Holy Roman Empire
French and Indian Wars (Queen Anne's War; King George's War)
Louis (XIV)
Maria Theresa
Marlborough, Duke of
Seven Years' War
Utrecht, Peace of

SUCCORY. See CHICORY.

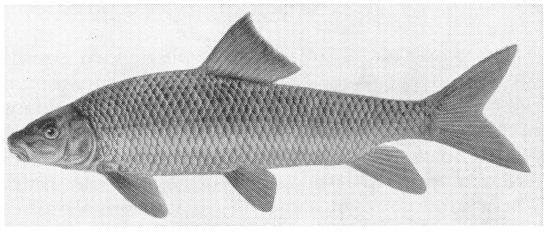
SUCCOT. See SUKKOT.

SUCCULENT, *SUK yoo lunt*, is the name for a fleshy plant, such as the cactus, that has large stems or leaves in which to store water. Succulent plants grow in deserts and other dry places in the world where there is little water. Desert plants have large stems or leaves in which to store water. MARCUS MAXON

See also CACTUS; SEDUM; SPURGE FAMILY.

SUCHOU. See SOOCHOW.

SUCKER is the name given to several kinds of fish closely related to the minnow family. Most of them have mouths with thick, fleshy lips that help them suck up animal and plant life on the bottom of lakes and



National Film Board

The Sucker has thick lips on the underside of the snout. Its mouth has no teeth, but its throat is lined with thin, comblike spines. Suckers live in lakes and streams.

streams. Except for a few kinds in eastern Asia, all the suckers are native to North America. These fish are dull-colored except in the spring, when the males of some species have a rose or orange stripe. The larger kinds of suckers are food fishes. They have a sweet-tasting, but bony, flesh. In the Mississippi Valley, fishermen catch large, carplike suckers known as buffalo fishes.

Scientific Classification. The sucker belongs to the sucker family, *Catostomidae*. The common sucker is genus *Catostomus*, species *C. commersonii*. The bigmouth buffalo fish is *Megastomatobus cyprinella;* the smallmouth buffalo fish, *Ictiobus bubalus;* and the black buffalo fish is classified as *I. niger*. CARL L. HUBBS

SUCKLING, SIR JOHN (1609-1642), was the most famous member of the *Cavalier poets*, a group associated with the court of King Charles I of England. Suckling's poetry is seldom serious, but its amateur quality has its own charm. Suckling's best verse has a witty and knowing quality, as in:

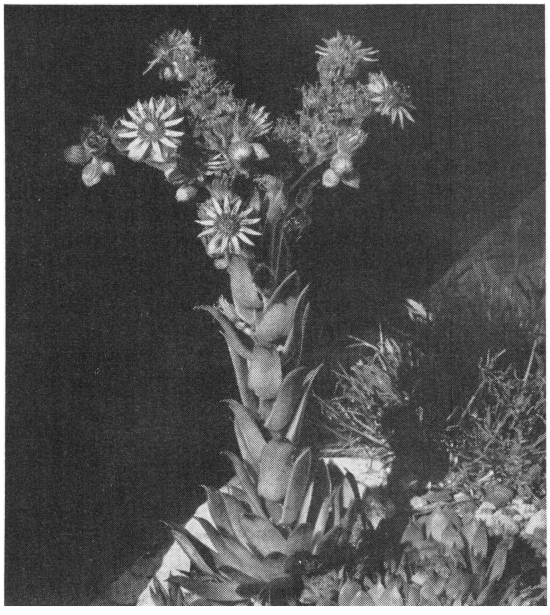
'Tis not the meat, but 'tis the appetite
Makes eating a delight.

Suckling's plays include *Aglaura* (1637). His short poems were published four years after his death in a collection of his writings titled *Fragmenta Aurea*. Suckling's ability as a literary critic can be seen in "A Session of Poets" (1637), a verse review of poetry in his day.

Suckling was born in Middlesex, and served in the army. In 1641, he was accused of plotting to gain control of the army for the king. He fled to Paris and died there, perhaps as a suicide. RICHARD S. SYLVESTER

Sempervivum Is an Example of a Succulent Plant.

J. Horace McFarland



SUCRE, *SOO kray* (pop. 84,900), is the capital of Bolivia. But all of the government offices except the Supreme Court are located in La Paz. The government moved its offices from Sucre in 1898 because La Paz had better transportation connections with the rest of the country.

Sucre lies in central Bolivia in the *Cordillera Real* (Royal Range) of the Andes Mountains, at an altitude of 8,950 feet (2,728 meters) above sea level. For location, see BOLIVIA (color map). Sucre is the chief cultural center of the country.

Sucre is sometimes called the *city of four names*. When Spanish settlers founded Sucre in 1538, they called it La Plata. Later, its name was changed to Charcas and then to Chuquisaca. In 1826, it was named Sucre for General Antonio José de Sucre, the first president of Bolivia (see SUCRE, ANTONIO JOSÉ DE). The University of San Francisco Xavier, founded in 1624, is located in Sucre. The university is among the oldest western schools. ARTHUR P. WHITAKER

SUCRE, *SOO kray*, is a standard coin in Ecuador. The sucre is named after the South American patriot, Antonio José de Sucre. One hundred centavos equal one sucre.

For the value of a sucre in dollars, see MONEY (table: Values of Monetary Units).

SUCRE, *SOO kray*, ANTONIO JOSÉ DE (1795-1830), liberated Ecuador and Bolivia from Spain and served as the first president of Bolivia. He was one of the ablest generals of his time. His victory over the Spaniards at Ayacucho in 1824 put an end to Spanish rule in South America.

Culver

Antonio José de Sucre

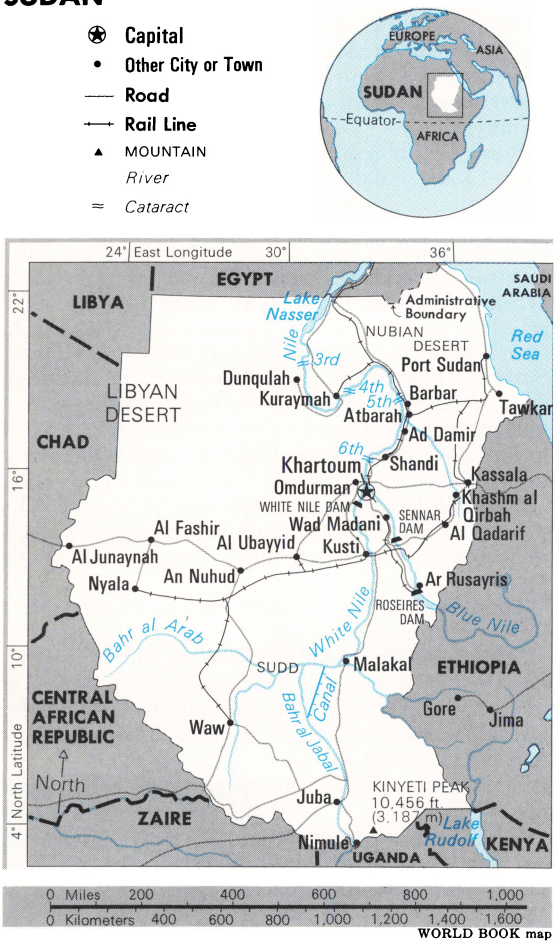
When Bolivia became a separate state, Sucre became its first president in 1826. He was an able administrator. He resigned the presidency in 1828 to prevent war with the Peruvians who objected to his friendship with Simón Bolívar (see BOLÍVAR, SIMÓN). Sucre was killed by an assassin in 1830. Bolivia named one of its most important cities in honor of him.

Sucre was born in Cumaná, Venezuela. He joined the revolutionary army when he was 15. He soon became Bolívar's trusted friend and chief lieutenant, and when Bolívar sought to free Ecuador, Sucre scored a victory at Pichincha in 1822. His strategy at Ayacucho freed Upper Peru, now Bolivia (see BOLIVIA [Independence]). HARVEY L. JOHNSON

SUCROSE is the chemical name for common table sugar. It has the chemical formula $C_{12}H_{22}O_{11}$. It is extracted from sugar beets and sugar cane and is the cheapest pure chemical produced on a large scale. Chemically, sucrose has certain properties of an alcohol, and it will form esters with organic acids (see ESTER). See also SUGAR.

SUCTION PUMP. See PUMP (Reciprocating Pumps [The Lift Pump]).

SUDAN



WORLD BOOK map

SUDAN, *soo DAN*, is the largest country in Africa. It lies in the northeastern part of the continent, and has a 400-mile (644-kilometer) coastline on the Red Sea. The Sudan is a land with widely differing people and geography. It sprawls across three distinct natural regions, ranging from bleak desert in the north to grassy plains in central Sudan and a great swamp and steaming tropical rainforest in the south.

Most of the people live near the Nile River or one of its branches, or near wells that can supply water for them and their crops. Only *nomads*, who roam in search of water and grazing land for their camels, sheep, goats, and cattle, live in many parts of the sandy north.

In the south, the swamp and the equatorial forest produce little food or cash crops. But big game, including the rare rhinoceros, lions, leopards, elephants, buffalo, giraffe, and other animals, roams there.

The contributor of this article, K. D. D. Henderson, a former member of the Sudan Political Service, is the author of Survey of the Anglo-Egyptian Sudan, The Making of Modern Sudan, *and* Sudan Republic.

The people of the Sudan are sharply divided. Arabic-speaking Moslems make up most of the population in the northern part of the country. They are descendants of African Negroes and *Nubians* (brown-skinned people related to the early Egyptians and Libyans). Several different tribes of African Negroes live in the south. These tribes lived in complete isolation from the rest of the world until the early 1800's. Most of the southerners speak tribal languages and practice tribal customs and religions.

The history of this ancient land dates back to Biblical times. The *pharaohs* (rulers) of ancient Egypt carried off valuable supplies of gold, the land's only mineral wealth. The Sudan was invaded and conquered by Egyptians, Romans, and Turks. Later, it was ruled jointly by Great Britain and Egypt for more than 50 years. During this period, it was called *Anglo-Egyptian Sudan.* It finally gained independence on Jan. 1, 1956.

The Sudan's official name in Arabic, the official language, is JUMHURIYAT AS SUDAN AD DIMUQRATIYAH (DEMOCRATIC REPUBLIC OF THE SUDAN). Khartoum, a city on the Nile River in central Sudan, is the country's capital and leading city.

Government. The Sudan's government has been overthrown several times since the nation became independent in 1956. Power has passed back and forth between civilian and military rulers.

According to the 1973 constitution, the president of the Sudan serves as head of state. He appoints members of the Cabinet to assist him in ruling the country. The People's Assembly serves as the nation's legislature. The Sudanese Socialist Union is the Sudan's only political party.

People. Most of the people in the Sudan are farmers or herders. The herders in the north keep camels and those in the south keep cattle.

Arabic-speaking Moslem people make up about two-thirds of the population, and most of them live in the northern two-thirds of the country. Descendants of Nubians and African Negroes, they have intermarried

FACTS IN BRIEF

Capital: Khartoum.

Official Language: Arabic.

Form of Government: Republic. *Head of State*—President.

Area: 967,500 sq. mi. (2,505,813 km²). *Greatest Distances*—north-south, 1,400 mi. (2,253 km); east-west, 1,075 mi. (1,730 km). *Coastline*—400 mi. (644 km).

Population: *Estimated 1976 Population*—18,343,000; distribution, 89 per cent rural, 11 per cent urban; density, 18 persons per sq. mi. (7 per km²). *1956 Census*—10,262,536. *Estimated 1981 Population*—20,957,000.

Chief Products: *Agriculture*—cassava, corn, cotton, dates, hides and skins, melons, millet, peanuts, sesame, wheat. *Forest Industry*—gum arabic, hardwood. *Manufacturing and Processing*—beer, cement, salt, shoes, soap, textiles.

Flag: Three horizontal stripes of red, white, and black, with a green triangle symbolizing Islam. Adopted in 1970. See FLAG (color picture: Flags of Africa).

Money: *Basic Unit*—Sudanese pound. See MONEY (table: Values).

with Arab peoples and adopted their language and religion. Most of these people live in the Nile River Valley and make their living as farmers. Some Beja tribes wander about the Red Sea hills with their herds.

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Negro tribes lived isolated from the rest of the world for hundreds of years, cut off by the great swamp of central Sudan and the thick rainforests. In the early 1800's, Egyptians and others invaded the swamps and jungles searching for slaves. This made the Negroes bitter and suspicious of other people. They have resisted efforts by northerners to convert them to the Islamic faith and to teach them to speak Arabic. Most of these tribesmen speak their own tribal languages, and practice tribal religions. They wear little clothing, and live in houses with mud walls and thatched roofs.

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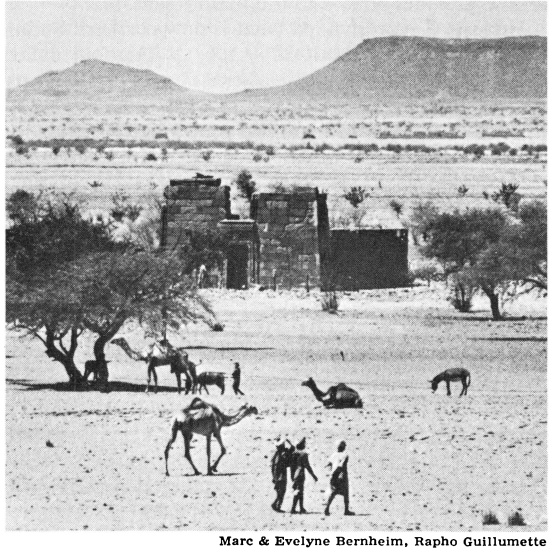
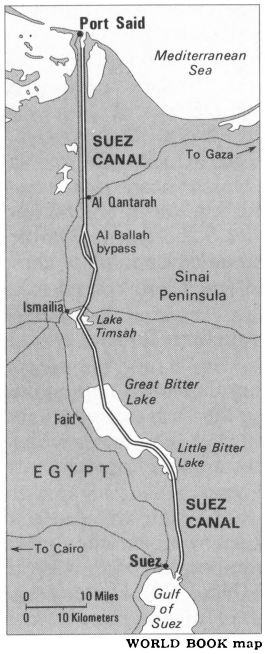


Marc & Evelyne Bernheim, Rapho Guillumette

Ruins in Northern Sudan date from about the A.D. 200's. They stand 35 miles (56 kilometers) from Shandi, north of Khartoum.

about 80 miles (130 kilometers) east of Cairo (see EGYPT [political map]). Railroads link the city with Cairo. Suez was seriously damaged during the Arab-Israeli wars of 1967 and 1973. Before these wars, the city was an oil-refining center and a refueling station for ships passing through the canal. Today, the city's chief industry is fertilizer production.

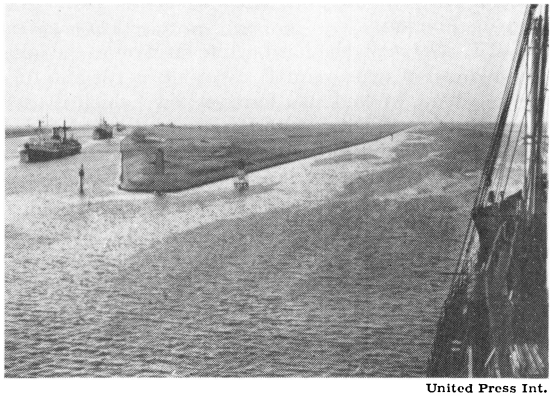
SUEZ CANAL, *soo EHZ,* is a narrow, man-made waterway in Egypt that extends about 100 miles (160 kilometers) to join the Mediterranean and Red seas. When the canal was opened in 1869, it shortened the route between England and India by 6,000 miles (9,700 kilometers). The canal had been the busiest interocean waterway in the world until it closed during the 1967 Arab-Israeli war. Tankers carrying petroleum and petroleum products had accounted for about 70 per cent of the total tonnage. Egypt reopened the canal to international traffic in 1975.



WORLD BOOK map
Suez Canal

The Suez Canal stretches north and south across the Isthmus of Suez, between the cities of Port Said and Suez. It has no locks because there is no great difference between the levels of the Red Sea and the Mediterranean Sea. Most of the canal can handle only single-lane traffic.

When the canal was constructed, it measured 26 feet (8 meters) deep, 72 feet (22 meters) wide at the bottom, and about 230 feet (70 meters) wide at the surface. It has been widened and deepened several times to handle larger ships and more traffic. Today, the canal is 46 feet (14 meters) deep, 118 feet (36 meters) wide at the bottom, and more than 390 feet (119 meters) wide at the surface. In 1975, Egypt began a $6-billion project to make the canal wide and deep enough to accommodate petroleum supertankers built since 1967.


United Press Int.
The Suez Canal extends from the Mediterranean Sea to the Gulf of Suez, an arm of the Red Sea. Southbound ships wait in the Al Ballah bypass, above, while northbound ships pass by.

History. Canals were built to connect the Nile River and the Red Sea hundreds of years before the time of Christ. For a time in the A.D. 600's, the Red and Mediterranean seas were joined by a canal. Napoleon I saw advantages of a waterway across the Isthmus of Suez when he visited Egypt in 1799. But Ferdinand de Lesseps, a French diplomat and canal builder, carried out the plan. He got permission for the project from Mohammed Said (Pasha), the Viceroy of Egypt, in 1854. An International Technical Commission met in 1855 to plan the canal route. By 1858, a company had been organized with a capital stock of about $40 million. Frenchmen and the Ottoman Empire owned most of the stock. Construction began on April 25, 1859, and the canal was opened on Nov. 17, 1869. The Suez Canal Company was given a concession that ended in 1968.

Although Britain gained more from the construction of the canal than any other country, it had no part in building the canal, and bought none of the original shares of stock. However, in 1875, Great Britain bought the shares of the Khedive of Egypt, Ismail Pasha, who had succeeded Mohammed Said (Pasha) as viceroy in 1863. After that, a commission composed mostly of British and French directed management of the canal.

In 1888, an international convention agreed that the canal should be open to all nations in peace and in war. However, Great Britain stationed troops near the canal for its defense in World War I, and kept ships of nations at war with Britain from using the waterway. Axis ships were denied use of the canal in World War II. In 1950, as a result of the Arab-Israeli war (1948-1949), Egypt banned Israeli ships from the canal.

Under the terms of a 1954 agreement with Egypt, British troops left the canal zone in June, 1956. In July, the United States and Great Britain withdrew offers to help finance the Aswan High Dam across the Nile River. This and other factors, including a strong Egyptian nationalist movement, led to the seizure of the canal by Egyptian President Gamal A. Nasser on July 26. Nasser announced that Egypt would use the canal tolls to build the dam. Great Britain, France, and other Western nations protested the seizure.

After years of border clashes, Israel invaded Egypt on Oct. 29, 1956. Great Britain and France attacked Egypt on October 31 in an effort to restore international control of the waterway. United Nations action ended the fighting on November 6. A United Nations police force restored peace in the area. The canal was reopened in March, 1957, under Egyptian management. It was blocked by sunken ships during the Arab-Israeli war in June, 1967. The Suez Canal was not reopened until June, 1975. WILLIAM A. HANCE

See also DE LESSEPS, FERDINAND MARIE; EGYPT; UNITED NATIONS (The Arab-Israeli Wars).

SUFFIX. See SPELLING (Spelling Rules).

SUFFOLK. See ENGLAND (political map).

SUFFOLK. See SHEEP (Medium-Wooled Sheep).

SUFFOLK UNIVERSITY. See UNIVERSITIES AND COLLEGES (table).

SUFFRAGE. See VOTING; WOMAN SUFFRAGE.

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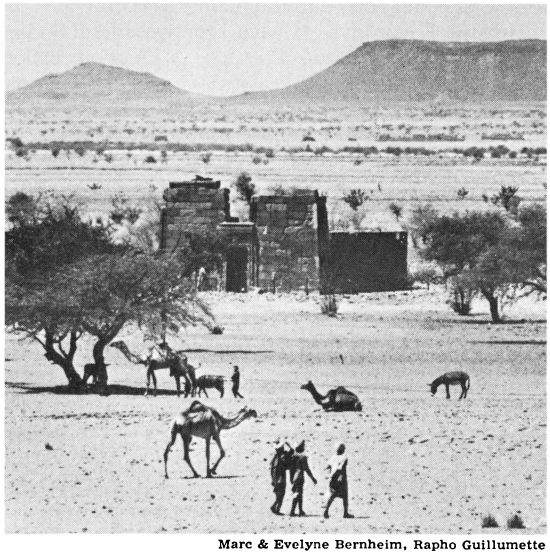

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United Nations

Women Shoppers in Southern Sudan board a Nile River ferry, carrying purchases home in the earthenware pots.

Sudan's forests provide some hardwood. Nearly 90 per cent of the world's production of gum arabic, which is used in making perfumes and candy, come from forests in the Sudan (see GUM ARABIC). Farmers also produce some cassava, sesame, corn, rice, peanuts, coffee, and sweet potatoes. Of these, only peanuts are grown in sufficient amount to be an important export.

The Sudan has a good network of roads in the north. But in the marshy south, roads are expensive to build and maintain. The country has about 2,800 miles (4,510 kilometers) of narrow-gauge railroads, and about 3,000 miles (4,800 kilometers) of navigable rivers. An airline provides service to the main towns.

History. Egypt invaded what is now northern Sudan many times after about 3000 B.C. A kingdom called Kush existed in the northeastern part of the country from as early as 1500 B.C. to about A.D. 350. It was an important trading and cultural center (see KUSH).

Several Christian kingdoms grew up in the Sudan area during the A.D. 500's. Moslem Arabs captured all of them between the 1100's and the 1500's. In 1504, black-skinned Moslems called Funj established their capital at Sennar, south of what is now Wad Madani. The Funj conquered much of the Sudan, but their power declined during the 1700's. In 1821, Egypt conquered the Funj and gained control of the Sudan (see FUNJ SULTANATE).

In 1881, a Moslem leader named Muhammed Ahmed proclaimed himself the *Mahdi* (guide), and led a successful revolt against the Egyptians. His successor, Khalifa Abdullahi, ruled the Sudan until 1898, when British and Egyptian troops reconquered the country.

In 1899, Great Britain and Egypt made the Sudan a protectorate. The British appointed a governor general and provided most of the important officials. Some Egyptian nationalists opposed British domination of Sudan. In 1924, Egyptian troops in the Sudan mutinied against the British. The mutiny failed, and most Egyptian officials were expelled from the Sudan. Egypt took no further part in governing Sudan until 1936, when it signed a new agreement with Great Britain.

After World War II, educated Sudanese began to demand independence. In 1953, Great Britain and Egypt agreed on steps leading to self-government for the Sudan. The Sudan officially became an independent country on Jan. 1, 1956, despite the objections of the people living in southern Sudan.

The Sudan has been plagued by political unrest and civil war since independence. In 1958, Ibrahim Abboud, an army general, seized control of the government. He dissolved parliament and banned all political parties. Meanwhile, a revolt of Negroes in the south against domination by the Arabs had developed into a civil war. Abboud failed to settle the conflict, and he was forced to resign in 1964. The Sudan returned to civilian government. But the new government was unable to settle the unrest in the south and also failed to solve economic problems.

The government of the Sudan changed hands several times during the late 1960's. In October, 1969, Major General Gaafar al-Nimeiry took control of the government. Leftist military leaders overthrew Nimeiry's government in July, 1971. But Nimeiry regained control a few days after the revolt. Voters elected Nimeiry president of the Sudan in October, 1971.

In 1972, the government reached an agreement with the leaders of the rebel movement in the south. The agreement provided for some self-government for the south.

K. D. D. HENDERSON

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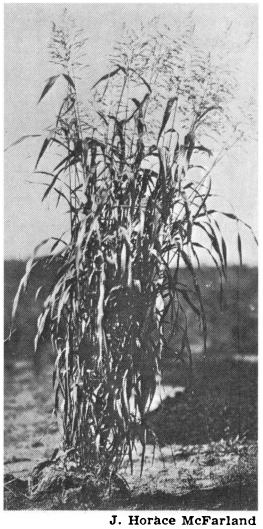
Gordon, Charles G.	Nubia	Port Sudan
Khartoum		

SUDAN GRASS is a hay plant that the Department of Agriculture introduced into the United States in 1909 from Khartoum, Sudan. It was first tested in Texas, and gave excellent results. Farmers planted this grass on vast areas of land in the South and Southwest. Eventually it spread to nearly all parts of the country. It is one of the best drought-resisting plants known to American farmers. Sudan grass has a fibrous root system. It is an annual, which means that seed must be planted every year. Farmers grow the grass for stock feed and for its seed. Sudan hay has a higher feeding value than timothy.



J. Horace McFarland

Sudan Grass makes excellent forage for livestock. It grows in almost any soil, and also in semiarid land regions.

Scientific Classification. Sudan grass is in the grass family, *Gramineae*. It is classified as genus *Sorghum*, species *S. vulgare*, variety *sudanense*.

ROY G. WIGGANS

SUDBURY, Ont. (pop. 100,446; met. area 155,424), is a world center of nickel production. Mines in and near the city produce about a fourth of the total nickel supply. Sudbury, which is often called the *Nickel Capital of the World*, lies about 250 miles (402 kilometers) northwest of Toronto. For location, see ONTARIO (political map).

Description. Sudbury covers about 115 square miles (298 square kilometers). Most of the city's people have English or French ancestors. Sudbury is the home of Laurentian University, where many classes are taught in both English and French.

Mining ranks as Sudbury's chief economic activity. About two-fifths of the city's workers are employed by companies that mine and process the rich ores found in the area. Nickel and copper are Sudbury's chief products. Iron and such precious metals as gold and platinum are also mined and processed in the area.

History. Huron Indians lived in what is now the Sudbury area before white settlers first arrived. In 1883, the Canadian Pacific Railway established the first permanent settlement there. James Worthington, the head of a railroad construction crew, named the community for the town of Sudbury in Suffolk, England. Also in 1883, the railroad's construction crews discovered the world's richest copper-nickel deposits near Sudbury.

Sudbury's first copper-mining company was formed in 1886. But major mining operations did not begin until after 1892, when a practical process for separating copper and nickel was developed. Sudbury was incorporated as a town in 1893. Its population rose from 795 that year to 18,075 in 1930, when it was incorporated as a city.

The world's two largest nickel-mining companies—the International Nickel Company of Canada, Limited (INCO) and Falconbridge Nickel Mines, Limited—were founded in Sudbury during the early 1900's. The city prospered during World War I (1914-1918) and World War II (1939-1945) because of the great demand for nickel. Manufacturers used the metal in making ammunition and armor plating. In 1950, Sudbury had a population of 42,410. In 1960, the city annexed several adjoining townships, and its population jumped to about 80,000.

Through the years, Sudbury's copper and nickel plants have caused much air pollution. In the early 1970's, the provincial government ordered the mining companies to greatly reduce the amount of harmful gases discharged into the air. One mining company built a smokestack that spread the gases over a large area and thus reduced the concentration of pollution in Sudbury. The smokestack, which was completed in 1972, rises 1,250 feet (381 meters) and is the tallest in the world.

Sudbury has a mayor-council form of government. The city's voters elect the mayor and nine aldermen to two-year terms. The council consists of all 10 of these officials. GEORGE GRACE

SUDDEN INFANT DEATH SYNDROME. See CRIB DEATH.

SUDERMANN, HERMANN (1857-1928), was a German dramatist and novelist associated with the naturalism movement. *Dame Care* (1887), his best-known novel, concerns a young man burdened with his father's failure in life. Through sacrifice, the son must master fate's repeated challenges. *Regina* (1890) is a historical novel showing an individual's struggle against the prejudices of his community.

Sudermann gained fame in Europe with his plays *Honor* (1889) and *Magda* (1893). In these dramas, he stripped away the pretenses of the middle-class society of the late 1800's. Sudermann's *Lithuanian Tales* (1917) skillfully portray working-class characters and carry a genuine sense of tragedy. Sudermann was born in Matzicken in East Prussia. WALTHER L. HAHN

SUDETENLAND, *soo DAY t'n land*, is a region located on the slopes of the Sudetes Mountains. It lies in Czechoslovakia, on the borders of Bohemia, Moravia, and Germany. Many Germans once lived in Sudetenland. The treaties of Versailles and St. Germain in 1919 gave the area to Czechoslovakia. The Munich Agreement of 1938 gave the area and other Czech areas to Germany. In 1945, the Allies restored Sudetenland to Czechoslovakia and the Germans were expelled and replaced with the Czechs and Slovaks. M. KAMIL DZIEWANOWSKI

SUDETES MOUNTAINS, *soo DE teez*, a European mountain range, separate northeastern Czechoslovakia and southwestern Poland. The highest part of the Sudetes is the Riesengebirge, which means *giant mountains*. The highest point, called Śnieżka in Poland and Sněžka in Czechoslovakia, rises 5,256 feet (1,602 meters) above sea level. Pine forests cover most of these peaks. The lower slopes of the Sudetes in Poland have coal reserves. FRANKLIN CARL ERICKSON

See also CZECHOSLOVAKIA (picture: Sudetes Mountains; Terrain Map).

SUEDE, *swayd*, is a soft leather that has a nap on one side. Suede is made by holding the flesh side of tanned animal hide against a buffing wheel. The rough surface of the wheel raises the nap. Items made from suede include shoes, gloves, hats, and coats.

SUESS, EDUARD (1831-1914), an Austrian geologist, became famous for his work on changes of the earth's surface. His most important book was the four-volume *Face of the Earth* (1885-1901). He served as an assistant at the Hofmuseum in Vienna from 1852 to 1862, and taught at the University of Vienna from 1857 to 1901. He was an inspiring teacher of advanced students. From 1869 to 1896, he served as leader of the Liberal party in the Austrian Parliament. Suess was born in London. CARROLL LANE FENTON

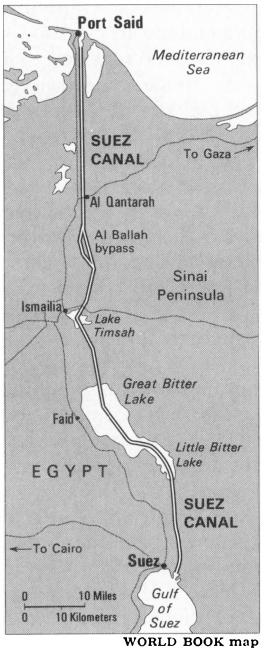
SUET, *SOO iht*, is the hard, white fat around the loins and kidneys of some animals, especially cattle and full-grown sheep. Melted suet forms tallow, which is used in making candles and soap. Beef suet is used for frying and other cooking methods. Many people use suet as bird feed in the winter. JOHN C. AYRES

SUETONIUS, *swee TOH nih us* (A.D. 69?-140), a Roman author, wrote a series of biographies of Roman emperors from Julius Caesar to Domitian in his *Lives of the Caesars*. This work is important not only for the information it gives us about these men, but also because it had a great influence on the writing of biography in ancient times and in the Middle Ages. All his other works are lost except his lives of grammarians, orators, and some other literary men. THOMAS A. BRADY

SUEZ, *soo EHZ* (pop. 260,422), is an Egyptian seaport at the southern entrance to the Suez Canal. It lies

about 80 miles (130 kilometers) east of Cairo (see EGYPT [political map]). Railroads link the city with Cairo. Suez was seriously damaged during the Arab-Israeli wars of 1967 and 1973. Before these wars, the city was an oil-refining center and a refueling station for ships passing through the canal. Today, the city's chief industry is fertilizer production.

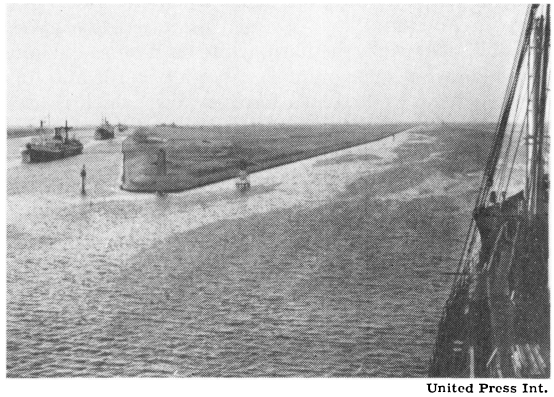
SUEZ CANAL, *soo EHZ,* is a narrow, man-made waterway in Egypt that extends about 100 miles (160 kilometers) to join the Mediterranean and Red seas. When the canal was opened in 1869, it shortened the route between England and India by 6,000 miles (9,700 kilometers). The canal had been the busiest interocean waterway in the world until it closed during the 1967 Arab-Israeli war. Tankers carrying petroleum and petroleum products had accounted for about 70 per cent of the total tonnage. Egypt reopened the canal to international traffic in 1975.



WORLD BOOK map
Suez Canal

The Suez Canal stretches north and south across the Isthmus of Suez, between the cities of Port Said and Suez. It has no locks because there is no great difference between the levels of the Red Sea and the Mediterranean Sea. Most of the canal can handle only single-lane traffic.

When the canal was constructed, it measured 26 feet (8 meters) deep, 72 feet (22 meters) wide at the bottom, and about 230 feet (70 meters) wide at the surface. It has been widened and deepened several times to handle larger ships and more traffic. Today, the canal is 46 feet (14 meters) deep, 118 feet (36 meters) wide at the bottom, and more than 390 feet (119 meters) wide at the surface. In 1975, Egypt began a $6-billion project to make the canal wide and deep enough to accommodate petroleum supertankers built since 1967.


United Press Int.
The Suez Canal extends from the Mediterranean Sea to the Gulf of Suez, an arm of the Red Sea. Southbound ships wait in the Al Ballah bypass, above, while northbound ships pass by.

History. Canals were built to connect the Nile River and the Red Sea hundreds of years before the time of Christ. For a time in the A.D. 600's, the Red and Mediterranean seas were joined by a canal. Napoleon I saw advantages of a waterway across the Isthmus of Suez when he visited Egypt in 1799. But Ferdinand de Lesseps, a French diplomat and canal builder, carried out the plan. He got permission for the project from Mohammed Said (Pasha), the Viceroy of Egypt, in 1854. An International Technical Commission met in 1855 to plan the canal route. By 1858, a company had been organized with a capital stock of about $40 million. Frenchmen and the Ottoman Empire owned most of the stock. Construction began on April 25, 1859, and the canal was opened on Nov. 17, 1869. The Suez Canal Company was given a concession that ended in 1968.

Although Britain gained more from the construction of the canal than any other country, it had no part in building the canal, and bought none of the original shares of stock. However, in 1875, Great Britain bought the shares of the Khedive of Egypt, Ismail Pasha, who had succeeded Mohammed Said (Pasha) as viceroy in 1863. After that, a commission composed mostly of British and French directed management of the canal.

In 1888, an international convention agreed that the canal should be open to all nations in peace and in war. However, Great Britain stationed troops near the canal for its defense in World War I, and kept ships of nations at war with Britain from using the waterway. Axis ships were denied use of the canal in World War II. In 1950, as a result of the Arab-Israeli war (1948-1949), Egypt banned Israeli ships from the canal.

Under the terms of a 1954 agreement with Egypt, British troops left the canal zone in June, 1956. In July, the United States and Great Britain withdrew offers to help finance the Aswan High Dam across the Nile River. This and other factors, including a strong Egyptian nationalist movement, led to the seizure of the canal by Egyptian President Gamal A. Nasser on July 26. Nasser announced that Egypt would use the canal tolls to build the dam. Great Britain, France, and other Western nations protested the seizure.

After years of border clashes, Israel invaded Egypt on Oct. 29, 1956. Great Britain and France attacked Egypt on October 31 in an effort to restore international control of the waterway. United Nations action ended the fighting on November 6. A United Nations police force restored peace in the area. The canal was reopened in March, 1957, under Egyptian management. It was blocked by sunken ships during the Arab-Israeli war in June, 1967. The Suez Canal was not reopened until June, 1975. WILLIAM A. HANCE

See also DE LESSEPS, FERDINAND MARIE; EGYPT; UNITED NATIONS (The Arab-Israeli Wars).

SUFFIX. See SPELLING (Spelling Rules).

SUFFOLK. See ENGLAND (political map).

SUFFOLK. See SHEEP (Medium-Wooled Sheep).

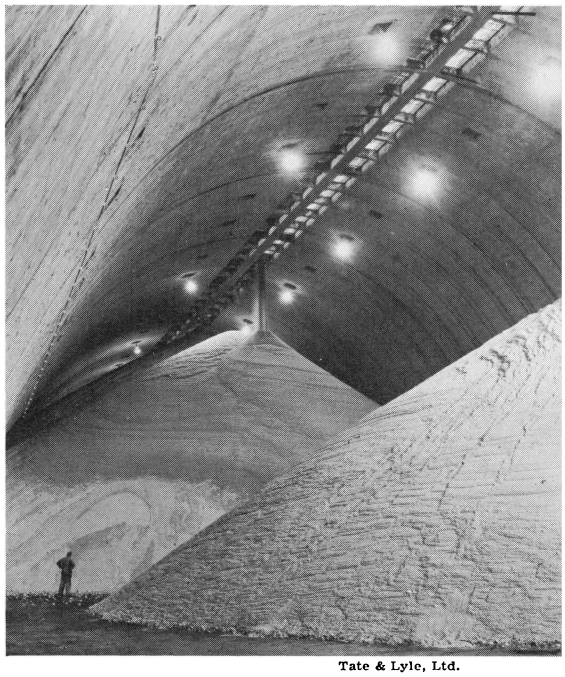
SUFFOLK UNIVERSITY. See UNIVERSITIES AND COLLEGES (table).

SUFFRAGE. See VOTING; WOMAN SUFFRAGE.

Grant Heilman

Utah-Idaho Sugar Co.

Most Sugar Comes from Sugar Cane and Sugar Beets. Workmen cut the sugar cane stalks with sharp steel knives, *top*. Farmers use machines, *bottom*, to pull sugar beets out of the ground and load them on wagons.



Tate & Lyle, Ltd.

Raw Sugar Is Stored in Huge Warehouses. Later, trains and trucks carry the raw sugar to refineries, where it is made suitable for eating.

SUGAR is one of man's most important foods. It is so important that it sometimes has been called the *foundation of life*. Sugar supplies energy and heat for the body much as gasoline provides power and heat for an automobile.

In addition to being important as a food, sugar is tasty. People like the sweet taste of sugar and use it to improve the flavor of many other kinds of food. All green plants make sugar. Most of the sugar we use for sweetening comes from sugar cane and sugar beets. Other sources of sugar include the maple tree, corn, grapes, and milk.

Sugar is distributed to industrial and home users in several forms. These include liquid, powdered, and various sizes of crystallized sugars. Pure white sugar and several brown sugars are produced. The sugars are delivered in packages varying in size from $\frac{1}{6}$ ounce (4.7 grams) to 100-pound (45-kilogram) bags. Bulk shipments of sugar are transported by truck or railroad freight car.

Properties of Sugar

Sugar is a sweet solid or liquid substance that is white or colorless when it is pure. Sugar is a *carbohydrate* (see CARBOHYDRATE). It furnishes energy faster than any other food. One teaspoonful (5 milliliters) of sugar contains 16 calories of energy. One pound (0.45 kilogram) of sugar contains about 1,750 calories.

Neil L. Pennington, the contributor of this article, is General Manager of California and Hawaiian Sugar Refining Corporation, Ltd., in Crockett, Calif.

Chemists call the sugar that people keep in a sugar bowl *sucrose* (chemical formula, $C_{12}H_{22}O_{11}$). By means of chemical methods, they can break it down into two other sugars that are simpler in chemical makeup (chemical formula, $C_6H_{12}O_6$). One of these is *glucose* (sometimes called *dextrose*). The other is *fructose* (also called *levulose*).

Uses of Sugar

As a Food. On the average, a person in the United States uses about 100 pounds (45 kilograms) of sugar a year. The most familiar form of sugar is the white granular kind used to flavor such foods as cereal, coffee, and tea. But most of the sugar used in the U.S. never appears in the sugar bowl. More than half of it is used in five types of food products. They are (1) soft drinks; (2) baked goods; (3) confectionery, including chocolates; (4) canned fruit, including jams, jellies, and marmalades; and (5) frozen desserts, mostly ice cream. Sugar is used to bring out the taste and smell of fruits, and to cover up the bitter taste of drugs.

In Industry. Many products are manufactured from sugar and its by-products. Manufacturers make nylon from *furfural* obtained by treating sugar-cane fibers with acid. *Monosodium glutamate*, a widely used substance for bringing out the flavor of food, may be made from beet molasses. Chemists make a *plasticizer*, a material that makes plastics tougher and less brittle, from sugar. One of the ingredients used to make carbon paper is cane wax, a whitish, powdery material that coats sugar-cane stalks. Some phonograph records contain a resin made from sugar-cane fiber. Paper and

wallboard are made from this fiber. Many cosmetics, drugs, and dyes contain sugar. Sugar is also an important ingredient in the manufacture of synthetic rubber. Raw cane sugar is used to keep tobacco from drying out while it is in storage.

Sources of Sugar

Sugar cane and sugar beets produce most of the sugar for commercial use. All other plants also produce sugar. Other sources of sugar are the maple tree, milk, and cornstarch.

Sugar Cane and Sugar Beets. Sugar cane grows in tropical or subtropical climates. The sugar beet thrives in temperate zones. When the sugar is *refined* (purified), there is no difference in the chemical composition of sugar obtained from either of these plants. For more detailed information on these sources of sugar, see SUGAR CANE; SUGAR BEET.

Plants. Almost all plants manufacture sugar. The plants' green leaves use energy from sunlight, water from the soil, and carbon dioxide from the air to form sugar and oxygen. This process is called photosynthesis. See PHOTOSYNTHESIS.

It has been estimated that all of the plants on earth make about 400 billion short tons (360 billion metric tons) of sugar in a year. About 80 per cent of the food energy of fruits comes from their sugar content. Sugar is found in such familiar foods as carrots, nuts, onions, and spinach.

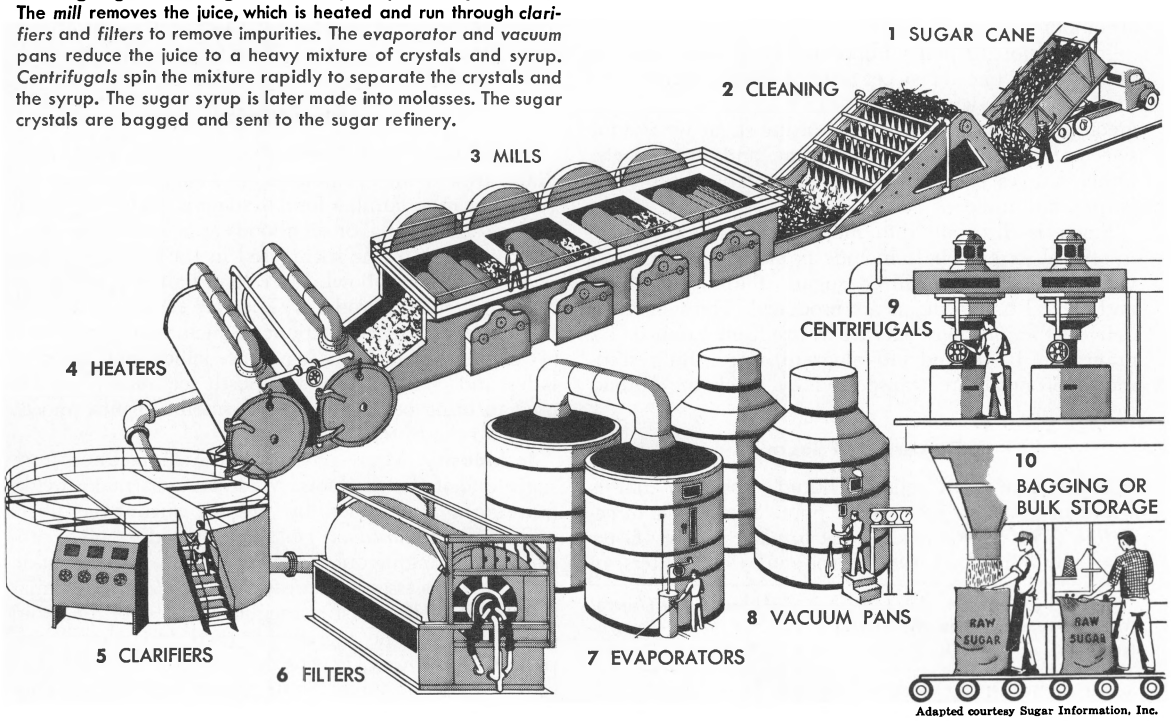
The type of sugar found most often in plants is sucrose. It is found throughout the stems and leaves of plants. Glucose and fructose also occur widely in nature. For example, honey and sweet fruits such as grapes are made up mostly of glucose and fructose. A mixture of equal parts of glucose and fructose is called *invert sugar*. Invert sugar is formed during the canning, preserving, and bottling of foods.

Maple Sugar and Syrup are obtained by collecting the sap of the sugar maple tree and refining it. The sap is boiled in an *evaporator*. See MAPLE; MAPLE SUGAR.

Milk Sugar is found in the milk of all mammals (milk-giving animals). Chemists call it *lactose*. Milk sugar for commercial use is usually obtained as a by-product of cheese manufacture. Cheese makers need only the milk solids. They separate the *casein* (protein) which forms the *curd* (solids), from the liquid called *whey* (see CHEESE). The whey contains the milk sugar, which can be obtained by drying and refining. Milk sugar is much less sweet than cane, beet, or maple sugar. It is valuable when only a little sweetness is wanted. For example, when a drug maker wants to dilute a powerful drug, he often uses milk sugar. By mixing the powdered drug with large amounts of milk sugar, he can make a small pill that is not too sweet.

Corn Sugar and Syrup. Manufacturers make corn syrup from cornstarch. To obtain the sugar, weak solutions of an acid are added to cornstarch. The acid used is hydrochloric acid, which is also found in the stomachs of human beings. It helps to digest food (see HYDROCHLORIC ACID). The cornstarch, acid, and water are heated until they boil. Workers pour the hot liquid through filters to remove impurities. Huge tanks keep the liquid hot and evaporate the water until the syrup becomes thick enough for use.

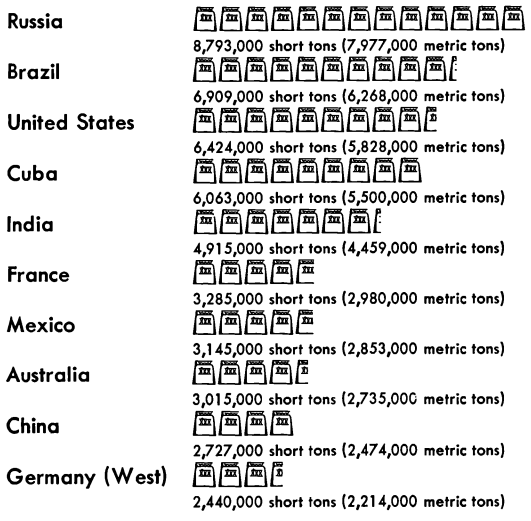
Making Sugar from Sugar Cane begins by cleaning the stalks. The *mill* removes the juice, which is heated and run through *clarifiers* and *filters* to remove impurities. The *evaporator* and *vacuum* pans reduce the juice to a heavy mixture of crystals and syrup. *Centrifugals* spin the mixture rapidly to separate the crystals and the syrup. The sugar syrup is later made into molasses. The sugar crystals are bagged and sent to the sugar refinery.



Adapted courtesy Sugar Information, Inc.

LEADING SUGAR-PRODUCING COUNTRIES

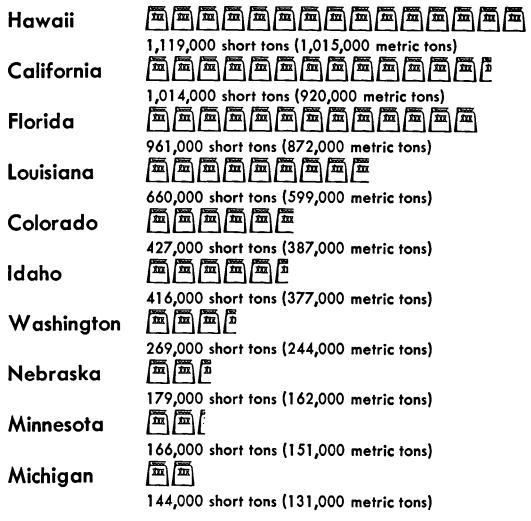
Tons of raw beet and cane sugar produced in 1972



Source: U.S. Department of Agriculture.

LEADING SUGAR-PRODUCING STATES

Tons of raw beet and cane sugar produced in 1972



Sources: U.S. Beet Sugar Association; U.S. Department of Agriculture.

Corn sugar is commercially produced *glucose*. Corn syrup and sugar are widely used in candy, canned fruit, and bread. They are not as sweet as cane sugar, but are sweeter than milk sugar. Manufacturers who make syrups for pancakes or waffles often add cane sugar to the corn syrups to make them sweeter.

Molasses is a by-product of cane sugar and beet sugar. It contains from 36 to 50 per cent sugar. Chemists and drug manufacturers use it to make many chemical products, including industrial alcohol. Molasses yields large amounts of citric acid, the ingredient that gives a tart flavor to lemons and oranges. Makers of soft drinks use the citric acid from molasses in beverages. Low-grade molasses, called blackstrap, is fed to livestock.

Molasses that is to be eaten contains much sugar, so it tastes sweet. It lends flavor to cookies and candy. Special kinds of bacteria act upon molasses so that *riboflavin* (vitamin B_2) can be made from it. See MOLASSES; VITAMIN (Vitamin B Complex).

Honey serves as another source of sugar. It does not need refining. Honey is sold in its liquid form, just as it is taken from the comb where the bees have stored it. See HONEY.

Making Cane Sugar

Planting the Cane. Planters put short pieces of cane stalks in the ground and cover them lightly with earth. In a short time, new stalks grow from the joints of the old cane. They grow 7 to 15 feet (2 to 5 meters) high. After the growing season, which may be from 7 to 22 months, workers usually cut the cane by hand. Machines are also used. Trucks, tractors, or trains take the cut cane to a sugar mill.

Processing the Cane. When the cane arrives at the sugar mill, it goes through a washing machine. After a thorough washing, the cane moves to a shredding machine, where knives shred the stalks. The shredded stalks are then put into a crushing machine. This machine has a series of revolving, heavy steel rollers that squeeze the cane under heavy pressure. The pressure bursts the cells inside the cane, squeezing out sweet juice. Sprays of water dissolve more sugar from the shredded stalks. The mixture of water and juice is then taken away for purifying. The fibers that remain are *bagasse*, which is either used as fuel for boilers in the mill or made into paper, wallboard, or furfural.

Obtaining Raw Sugar. The cane juice, still diluted with water, is heated. Lime added to the juice settles out some of the impurities. Workers put the juice in huge evaporator tanks. There, most of the water evaporates and the juice becomes thick and syrupy. However, more water must be taken out of the syrup so that crystals will form. Because sugar and sugar syrup scorch easily, the syrup is heated in great dome-shaped vacuum pans to remove excess water. The vacuum lowers the boiling point of the syrup so that even though heating is continued, the syrup will not scorch.

Large sugar crystals soon begin to form in the thick syrup. To separate the crystals from the molasses, workmen put the mixture in a *centrifuge*. This machine turns around and around at exceedingly high speeds and spins most of the molasses from the sugar (see CENTRIFUGE). What remains is called *raw sugar*, which contains from 97 to 99 per cent sucrose. Exporters ship sugar in this form from one country to another. But to make it suitable for food, raw sugar must be further refined.

Refining Cane Sugar. To obtain pure white sugar for table use, the yellowish-brown raw sugar must go through several more steps. First, the molasses film, which gives the raw sugar its color, must be rinsed off. Then the sugar crystals are dissolved in water and this solution is poured through filters. The filters usually contain boneblack or some form of carbon. When a clear, colorless liquid is obtained, the evaporating proc-

ess is repeated until crystals form again. Once more, the centrifuge spins the syrup from the crystals, and sparkling white, pure crystalline sugar flows from the machine to drying drums. In these drums, heated air absorbs any moisture that remains. Conveyors move the sugar to packaging machines, which automatically weigh and package it for market.

But all of the syrup has not formed crystals during this procedure. So the remaining syrup goes back through the evaporation and spinning processes again. Another batch of white sugar crystals is formed. The remaining syrup is processed for the third and last time. From this, brown sugar is made.

Making Beet Sugar

The sugar beet is related to the red garden beet, but it is white and has a high sugar content. Farmers grow sugar beets from seeds. They plant the seeds, and when the plants begin to grow, some of them are removed so that the remaining beets will have plenty of room. At the end of the growing season, the beet tops are removed and used as cattle feed. Machines pull up the roots and haul them to the sugar-making factory.

Removing Beet Sugar. In the factory, washing and cutting machines clean the beets and slice them to about the size and shape of shoestring potatoes. The *cossetts* (beet slices) are put in *diffusers* (vats of hot water) to soak. This soaking removes the sugar from the slices. The *pulp* (beet slices) that remains is removed and dried. The dried pulp is sometimes made into pellets for other uses, such as cattle feed. Usually, the final molasses obtained after beet sugar is refined is added to the beet pulp to make it a more valuable feed for cattle.

Refining Beet Sugar. The solution obtained by soaking the beets is treated with lime and carbon dioxide. Filters remove the impurities. The sugar is crystallized by evaporating the water, much as in the making of cane sugar. However, in the United States, beet-sugar processing is carried out in a single operation. Beet-sugar factories produce no raw sugar. The centrifuge spins off the molasses and leaves behind a white, sparkling sugar that contains about 99.96 per cent sucrose.

History

Sugar cane was known at the time of Alexander the Great. Records of one of his expeditions down the Indus River in 325 B.C. show that "honey-bearing reeds" were found. The Bible mentions sugar as an article of great value. Dioscorides, a Greek physician who lived during the time of the Roman emperor Nero, wrote: "There is a sort of hard honey which is called saccharum (sugar) found upon canes in India. It is grainy like salt and brittle between the teeth, but of sweet taste withal."

The Moors brought sugar cane with them when they overran Spain in the A.D. 700's. For the next 200 years, the only sugar raised in Europe was that in Spain. From the 900's through the 1100's, the city of Venice became the center of a flourishing sugar trade. The Venetians brought sugar from the Tigris-Euphrates Valley, and from Egypt and Syria. It was sold to tradesmen throughout Europe. But because of the difficulty of obtaining the sugar, prices were very high and the quantities were limited. For these reasons, sugar planting started in southern France and Italy, throughout North Africa, and on islands in the Atlantic Ocean near Spain in the early 1300's.

In Venice during the 1400's, an inventor molded sugar into loaves and cones. For more than 400 years afterwards, all refined sugar was molded before it was sold. Although sugar had been used in Europe since the Middle Ages, crude refining methods and distribution made it a luxury. In London in 1742, sugar sold for the equivalent of $2.75 per pound ($6 per kilogram).

Columbus brought cuttings of sugar cane to the Western Hemisphere on his second voyage. He planted it in Santo Domingo in what is now the Dominican Republic. The first sugar mill in the Western Hemisphere was built in 1508 in Isabela, a village near Santo Domingo.

After his conquest of Mexico, Cortes established two plantations. From these beginnings, the cultivation of sugar cane spread to Brazil, Peru, and Argentina. By the middle of the 1600's, tropical America became the greatest sugar-producing area in the world.

Jesuit missionaries introduced sugar cane into Louisiana in 1751. The first sugar mill in North America was set up at New Orleans by Antonio Mendez, in 1791. Étienne de Boré produced the first granulated sugar in 1795 (see BORÉ, ÉTIENNE DE).

In 1794, Andreas Marggraf, a German scientist, first took sugar from beets. In 1838, sugar beets were planted in Massachusetts. The first successful factory was established in Alvarado, Calif. Twenty-two states in the United States now grow sugar beets. One-third of the sugar consumed in the United States is beet sugar.

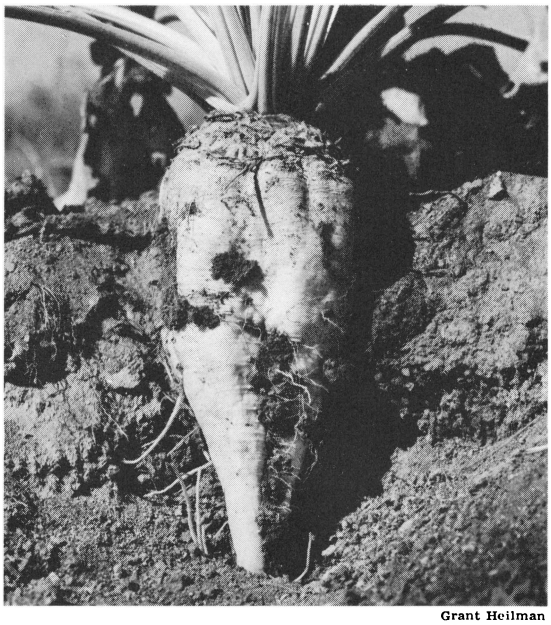
NEIL L. PENNINGTON

Related Articles in WORLD BOOK include:

Candy	Honey	Saccharin
Carbohydrate	Maltose	Sucrose
Cellulose	Maple Sugar	Sugar Beet
Dextrose	Molasses	Sugar Cane
Glucose		

SUGAR BEET is grown for the sugar that is obtained from its root. It is a *biennial* plant, because it takes two years for the plant to mature. During the first year, it grows a large fleshy root, a fleshy stem, and a cluster of leaves. The silvery-white beet is the enlarged upper part of the root, weighing 2 pounds (0.9 kilogram) or more. The rest of the root tapers down from the beet. It is long and slender, with many threadlike branches. This taproot grows 2 to 7 feet (0.6 to 2 meters) straight into the ground. The top of the beet is called the *crown*, and is very short. It sends out bunches of brilliant, rich green leaves, about 14 inches (36 centimeters) long. After one year, the sugar beet is usually dug up and sent to the sugar refinery. If left in the ground for the second year, the plant sends out long branches that produce tiny flowers containing seeds. These flowers may be either reddish or greenish. Sugar beets are most profitably grown where there are six frost-free months each year. An average summer temperature of 67° to 72° F. (19° to 22° C), with cool nights and warm days, is considered most favorable.

The fleshy root of the sugar beet ranks second only to sugar cane among important sources of sugar. The beet contains from 13 to 22 per cent sugar. It is made up of small cells and large cells. The small cells contain the sugar and the large cells store water. These cells are arranged in rings called *cambium* rings. The rings can be



Grant Heilman

Sugar Beets rank second only to sugar cane as a source of sugar. The silvery-white beet is the enlarged upper part of the root. Farmers feed the green leaves and beet tops to livestock.

LEADING SUGAR BEET GROWING COUNTRIES

Tons of sugar beets grown in 1972

Russia	83,445,000 short tons (75,700,000 metric tons)
United States	28,523,000 short tons (25,876,000 metric tons)
France	20,579,000 short tons (18,669,000 metric tons)
Germany (West)	16,155,000 short tons (14,656,000 metric tons)
Poland	15,763,000 short tons (14,300,000 metric tons)
Italy	11,778,000 short tons (10,685,000 metric tons)
Czechoslovakia	7,905,000 short tons (7,171,000 metric tons)
Great Britain	7,000,000 short tons (6,350,000 metric tons)
Germany (East)	6,834,000 short tons (6,200,000 metric tons)
China	6,614,000 short tons (6,000,000 metric tons)

Source: *Production Yearbook, 1972*, FAO.

seen when the beet is cut crosswise. Beets are planted, thinned, topped, and loaded mechanically.

Sugar is taken from the beets by washing the beets and cutting them into thin slices. These slices are put into hot water, which soaks the sugar from the beets. The syrup is purified mechanically, filtered, and boiled to sugar. The sugar is dried for market and packaged.

The entire sugar-beet plant is put to good use. The leaves of the plant are cooked as greens, or used like hay for their protein. The crown, or stem, can serve as food for cattle, sheep, hogs, and other animals. The pulp of the beet that remains after the sugar is extracted also is used as feed to fatten animals. The residue from the sugar-refining process is called *molasses*. Farmers use molasses to feed cattle and other livestock.

Several diseases attack sugar beets. These include leaf spot, black root, root rot, and curly top. Crop rotation and the planting of disease-resistant varieties of beets help control disease.

The sugar beet grew wild in Asia and was cultivated in ancient times in southern Europe and North Africa. Its first modern use for sugar came about 1800 in France and Germany. During the middle 1800's, the plant was brought to the United States. But sugar beets did not become an important source of sugar in the United States and Canada until after World War I. Their use greatly increased during World War II.

Scientific Classification. The sugar beet belongs to the goosefoot family *Chenopodiaceae*. It is classified as genus *Beta*, species *B. vulgaris*. NEIL L. PENNINGTON

See also BEET.

SUGAR BOWL. See NEW ORLEANS (Visiting New Orleans); FOOTBALL (table).

SUGAR CANE is a tall grass plant that grows in tropical and semitropical countries. It produces sturdy stalks 7 to 15 feet (2 to 5 meters) high, and about 2 inches (5 centimeters) in diameter. These stalks contain a large amount of sugary juice from which sugar and syrup are made.

Sugar cane grows from a thick, solid rootstock. The numerous stalks have no branches, but have long, narrow leaves which are arranged in two rows. The stalk is divided into several sections, like a bamboo cane. These sections are called *internodes*. Each node bears a small bud which looks much like a potato eye. The color of the stem varies from yellow to reddish.

Sugar cane first grew in India. It has been cultivated in India and China since early times. After the Crusades, travelers brought it to Europe. Colonizers brought sugar cane to America and the West Indies during the 1500's. Today, the leading sugar cane growing nations include India, Brazil, Cuba, China, Mexico, the United States, and Pakistan. Hawaii, Louisiana, and Florida rank as the chief U.S. sugar cane producers. The American people use so much sugar that nearly all the United States supply must be imported from Puerto Rico and from the Philippines and other countries.

Growth and Cultivation. The best soil for sugar cane is a fertile soil that can hold a large amount of moisture. The plant needs much water; growers must irrigate the plants if the region has little rainfall. The soils of Louisiana and Florida yield excellent crops. The soils of the Hawaiian Islands are rich in lime, potash, phosphoric acid, and nitrogen. The Hawaiian plantations yield the world's richest crops of sugar cane.

Sugar cane is grown chiefly from stem cuttings. Furrows from 5 to 7 feet (1.5 to 2.1 meters) apart are dug in the field. The cuttings are laid horizontally in the furrows. Some planters use only the upper part or the matured part of the cane. Others use the entire cane.

After the cuttings have been planted, soil is thrown over the furrows until the cane is covered. In a short time the buds borne on the nodes swell and burst, and young stalks of cane emerge from the soil. Soon the

LEADING SUGAR-CANE GROWING COUNTRIES

Tons of sugar cane grown in 1972

India	127,182,000 short tons (115,378,000 metric tons)
Brazil	92,594,000 short tons (84,000,000 metric tons)
Cuba	49,604,000 short tons (45,000,000 metric tons)
China	42,549,000 short tons (38,600,000 metric tons)
Mexico	37,479,000 short tons (34,000,000 metric tons)
United States	29,493,000 short tons (26,756,000 metric tons)
Pakistan	22,003,000 short tons (19,961,000 metric tons)
Australia	20,798,000 short tons (18,868,000 metric tons)
Colombia	19,687,000 short tons (17,860,000 metric tons)
Philippines	18,739,000 short tons (17,000,000 metric tons)

Source: *Production Yearbook, 1972*, FAO.

Werner Stoy, Camera Hawaii

A Cane Worker in Hawaii holds the sugar-rich section of a sugar cane stalk. Sugar is made from the sweet juice of the stalk.

leaves appear, and in a few weeks the stalks have developed nodes and internodes.

Harvesting. In Hawaii and Louisiana, machines are used to cut off the cane stalks. But in most other sugar cane growing areas, workers cut the cane by hand. Each cutter uses a large steel knife which has a blade 5 inches (13 centimeters) wide and 18 inches (48 centimeters) long, with a hook on the back. As the cutters move down the rows, they cut the cane close to the ground, strip off the leaves with the hook, and cut off the top of the stalk at the last matured joint.

The cut stalks are thrown into heaps called *windrows*, and then gathered up into carts or narrow-gauge railway cars that take them to the sugar factory. The stubble left in the field produces two or three crops in Louisiana and five to ten crops in tropical regions.

Scientific Classification. Sugar cane belongs to the grass family, *Gramineae*. It is classified as genus *Saccharum*, species *S. officinarum*. NEIL L. PENNINGTON

See also CUBA (picture: Workers Harvest Sugar Cane); HAWAII (Agriculture); PUERTO RICO (picture: Cutters Harvest Sugar Cane); SUGAR.

SUGAR LOAF MOUNTAIN. See RIO DE JANEIRO (picture); EARTH (History of the Earth [color picture]).

SUGAR MAPLE. See MAPLE (The Sugar Maple; pictures); MAPLE SYRUP.

SUGAR STATE. See LOUISIANA.

SUGARBERRY. See HACKBERRY.

SUGGESTION, in psychology, is the acceptance of an idea by the mind without critical thought. For example, if someone merely makes a throwing motion, many observers will be sure that something actually left his hand. They get this impression because the mind tends to complete a partial picture. Similarly, if a child says he feels ill, his mother may touch his forehead and assure herself that he has a fever, even though a thermometer would show that his temperature is normal.

A professional magician relies on suggestion for most of his effects. If he goes through the motion of tossing a coin into a cup, and if people in the audience hear the expected jingling sound, they assume the coin is in the cup. Advertisers use suggestion in many ways. No advertiser would dare guarantee that a girl will become popular by using his brand of soap or toothpaste. But his slogans may strongly suggest this result.

Children accept suggestions more easily than adults do, because they are less critical and less experienced. Most uneducated or prejudiced people also accept suggestion easily. People are more suggestible when they are worried, tired, or ill. FRANK J. KOBLER

See also HYPNOTISM; MAGIC.

SUHARTO, *soo HAR toe* (1921-), became president of Indonesia in 1968. He and other top military officers seized power from President Sukarno after they put down a Communist uprising in 1965. Sukarno was allowed to keep the title of president until 1967.

Under Suharto's leadership, Indonesia ended border fighting with Malaysia and rejoined the United Nations. Sukarno had withdrawn Indonesia from the United Nations in 1965.

Suharto was born on the island of Java. As a young man he served in the colonial army The Netherlands kept in Indonesia, then a colony called The Netherlands (Dutch) East Indies. But later, he fought the Dutch for Indonesian independence. After independence, he became lieutenant general in the Indonesian armed forces.

See also INDONESIA (History); SUKARNO.

SUI DYNASTY, *sway*, was a Chinese *dynasty* (family of rulers) that governed from A.D. 589 to 618. Yang Chien, the dynasty's first ruler, brought most of northern and southern China together as an empire after almost

400 years of civil war. Yang Chien died in 604, possibly murdered by his son, Sui Yang Ti, who then became ruler.

Yang Ti tried to improve and expand the empire. He built the Grand Canal, a waterway for shipping grain and other products. It extended almost 200 miles (320 kilometers), from Hangchow to Chen-chiang. Yang Ti failed in attempts to conquer Korea and Manchuria. After the Koreans defeated the Sui army in 612, the Chinese people became dissatisfied with the emperor and revolted. In 615, the Sui army suffered another defeat, by the Eastern Turks, and Yang Ti retreated to the south. He was assassinated in 618. His death marked the end of the Sui Dynasty. The T'ang Dynasty was founded that same year. EUGENE BOARDMAN

SUICIDE. A person who deliberately kills himself commits suicide. Many authorities think that suicide becomes more common as life grows more complex. Primitive peoples rarely commit suicide. City dwellers are far more likely to commit suicide than rural people. Laborers are much less likely to kill themselves than business and professional men.

Throughout the world, three or four times as many men as women kill themselves. Male suicides generally hang themselves, or use a knife or a gun. Women often choose drowning or poison as the means of death. Women who commit suicide usually do so much younger than men. Both men and women are less likely to kill themselves if they are married. Year after year, the number of suicides has always increased during the late spring and early summer months. The rate of suicide is highest among people in the age group between 55 and 65.

Various groups have held widely different attitudes toward suicide. Many ancient peoples held that a person's life was his own, to keep or give up as he pleased. Some persons in Japan consider suicide, called *hara-kiri*, a method of avoiding disgrace (see HARA-KIRI). Christianity has always considered suicide a sin, and many Christians have believed that the person who committed suicide gave up his hope of getting to heaven. Many churches still hold this view. Roman Catholics are less likely to commit suicide than Protestants. Jews have a still lower suicide rate. Suicide is against the law, but the would-be suicide knows he will be beyond the reach of the law if he succeeds in killing himself. The law sometimes punishes attempted suicide. JOHN W. WADE

SUIT, *soot.* When a person seeks the help of a court of law to enforce his rights, he is said to "bring suit." Someone who has suffered injury at the hands of another may bring suit for damages. A person also may bring suit to recover property, to collect money, to enforce the terms of a contract, or to accomplish one of many other purposes. A city, state, or other governmental unit may bring suit in the same way as a private person or a corporation. In general, a suit is any civil action brought before a court of law. Criminal prosecutions are not spoken of as suits. THOMAS A. COWAN

See also COURT (How a Court Works); STATUTE OF LIMITATIONS.

SUITE, *sweet.* There are two kinds of *suites* in music: classic and modern. The classic suite is a collection of dances grouped together for their contrasting style and rhythms. One dance may be slow and the next fast, one stately, and another gay, but they are all played in the same key. The classic suite was most popular in the 1600's and 1700's, and influenced the development of the *sonata*. The modern suite is a sequence of contrasting sections, usually connected by some idea or story, such as the *Nutcracker Suite* of Peter Ilich Tchaikovsky.

Suite also has other meanings, such as a suite of rooms or a set of matched furniture. RAYMOND KENDALL

See also GIGUE; SONATA.

SUKARNO (1901-1970) was president of Indonesia from 1945 to 1967. Anti-Communist military leaders took power from him in 1966, after Communists tried to overthrow the government. Sukarno retained the title of president until 1967. Indonesia was officially a "neutral" nation under Sukarno. But his statements and policies showed a leaning toward Communist China and Russia.

Sukarno was born in Surabaja, Java. He formed the Partai Nasional Indonesia (P.N.I.) in 1927, seeking independence from The Netherlands. After independence, Sukarno called for a "guided democracy" for Indonesia. By 1960, he held unrestricted power.

Sukarno brought West New Guinea (now Irian Jaya) under his control. He refused to recognize the Federation of Malaysia, claiming that Sabah should be part of Indonesia. He threatened to crush Malaysia, and began raids on the federation in 1964. He withdrew Indonesia from the United Nations in 1965 after Malaysia was seated on the Security Council. GEORGE E. TAYLOR

See also INDONESIA (Government; History).

SUKKOT, *sook OHT*, or FEAST OF TABERNACLES, is a Jewish festival that originally celebrated the end of the harvest season. It begins on the 15th day of the Hebrew month of Tishri, and lasts nine days. Jews in Israel and Reform Jews celebrate it for only eight days. The eighth day of Sukkot is called *Shemini Atzeret*. The ninth is *Simhat Torah* (see SIMHAT TORAH). During the festival, traditional Jews live in huts called *sukkot* as a reminder of the huts in which their ancestors lived during their wanderings in the wilderness.

The ancient Hebrews celebrated Sukkot as a festival of thanksgiving, and brought sacrifices to the Temple in Jerusalem. They formed joyous parades carrying *lulabs* (palm branches), *etrogs* (citrons), and myrtle and willow branches. These plants are still used in the celebrations today. LEONARD C. MISHKIN

SUL ROSS STATE UNIVERSITY. See UNIVERSITIES AND COLLEGES (table).

SULAWESI is the Indonesian name for the island of Celebes. See INDONESIA (The Islands; table).

SULEIMAN I, *soo lay MAHN* (1494-1566), became known in the Western world as THE MAGNIFICENT, but among his own people as THE LAWGIVER. He was the 10th ruler of the Ottoman Empire. He led armies into Hungary, and stormed the walls of Vienna. In Asia, his armies invaded Persia (Iran) and captured Tabriz and Baghdad. Suleiman's fleets dominated the Mediterranean Sea, the Red Sea, and the Persian Gulf. His sailors held North Africa, and raided the coasts of Spain, France, and Italy. Suleiman took Rhodes from the Knights of Saint John (see KNIGHTS OF SAINT JOHN). He revised the legal system. He quarreled with several of his sons, and executed two of them. See also TURKEY (The Ottoman Empire). SYDNEY N. FISHER

SULFA DRUGS

SULFA DRUGS, or SULFONAMIDES, are a group of chemicals that are used to fight bacteria and some other organisms that cause disease in the body. Thousands of lives have been saved with this valuable group of chemicals. Before scientists discovered the sulfonamides, about 12 of every 100 pneumococcal pneumonia victims died in spite of the use of a serum for pneumonia. After doctors began to use sulfa drugs, the death rate dropped to about 5 out of 100. Penicillin, which is not a sulfonamide, further reduced the death rate to from 3 to 5 in 100 cases. The use of sulfa drugs reduced the death rate in one form of meningitis from 35 to 50 out of every 100 cases to about 5 out of 100. These drugs contributed remarkably to the saving of lives in World War II.

Uses in Treating Diseases. The sulfa drugs are most commonly taken by mouth or by injection into the blood. They may also be applied directly to the skin as ointment or powder. However, some patients have *allergic* (sensitive) reactions when they are applied in this way. Sometimes sulfa drugs *crystallize* (solidify) in a patient's urine. For this reason, doctors may instruct patients taking sulfa drugs to drink large amounts of liquids and take bicarbonate of soda to keep the kidneys clear.

In general, sulfa drugs are used to treat diseases, such as pneumonia, dysentery, meningitis, blood poisoning, urinary tract infections, and some venereal diseases. Other diseases treated with sulfa drugs are erysipelas, cellulitis, bubonic plague, and cholera.

Sulfonamides are not effective against all bacteria. For example, they are not effective against organisms causing tuberculosis. Therefore, the physician often must identify the type of bacteria that is causing an infection before he knows whether to use a sulfa drug. To be effective, a certain concentration of sulfa must be kept in the body. Because of this, most physicians examine the blood and body fluids regularly to determine how much of the drug is in the body.

Normally, sulfa drugs do not actually kill bacteria. Instead, they prevent the bacteria from multiplying. Then the body's regular defenses usually kill the bacteria. Many bacteria need a chemical called *para-aminobenzoic acid* (PABA) to multiply. PABA acts like a necessary vitamin for these bacteria. The sulfonamide drugs have a chemical structure similar to PABA, but they have sulfur atoms where PABA has carbon atoms. Bacteria cannot tell the difference between the two and absorb the sulfa drug rather than the PABA. The sulfur atoms then stop one or more of the growth processes of the bacteria, and the bacteria cannot multiply.

All sulfa drugs contain sulfur, nitrogen, hydrogen, and oxygen. They are called sulfa drugs or sulfonamides because of their similar chemical makeup. But each one is a little different in structure.

Development of the Sulfa Drugs. Knowledge of the possible benefits of the sulfonamides dates back to 1908. In that year, Paul Gelmo, a German chemist who was looking for better dyes for woolen goods, discovered chemicals that eventually led to the sulfa drugs. But it was not until the early 1930's that sulfonamides could be used in medicine. In 1935, a German bacteriologist named Gerhard Domagk reported that the sulfonamide drug *Prontosil* killed streptococcal bacteria in mice. He was offered the Nobel prize in medicine for 1939 for his discovery, but the Nazi regime in Germany would not allow him to accept it.

Research in this new chemical spread quickly after Domagk's discovery. Researchers, particularly in France, England, and the United States, investigated thousands of related chemicals before they found the few that were the most useful.

Prontosil and Neoprontosil are trade names for two of the earliest sulfonamides. In the body, they release *sulfanilamide*, the active substance fighting against bacteria. Sulfanilamide, sulfapyrazine, and sulfathiazole were among the earliest sulfa drugs put into general use. But in time they were largely replaced by other sulfonamides that were more effective and less harmful.

The sulfa drugs now used for general body infections include sulfadimethoxine, sulfamethazine, sulfisoxazole, and sulfadiazine. Sulfa drugs that are used for infections in the intestinal tract include succinylsulfathiazole and phthalylsulfathiazole. SOLOMON GARB

SULFATE is a salt of sulfuric acid. As a rule, sulfates are stable compounds, formed in crystals. Most of them are fairly soluble in water. But such sulfates as barium, strontium, and lead sulfates do not dissolve in water. Heavy spar is a sulfate of barium; gypsum is a sulfate of calcium; celestite is a sulfate of strontium; and Epsom salt is a sulfate of magnesium. Sulfates have important industrial uses. Copper sulfate, or blue vitriol, is used in many industries, including dyeing and calico printing. Iron sulfate is used in making ink and as a medicine. Manganese sulfate is used in calico printing. Zinc sulfate is used in surgery as an antiseptic, in calico printing, and in drying oils for varnishes. Some baking powders contain *alum*, a double sulfate of potassium and aluminum. Every sulfate contains a group of associated atoms of sulfur and oxygen known in chemistry as the *sulfate radical* ($-SO_4$). See also ALUM; GYPSUM.

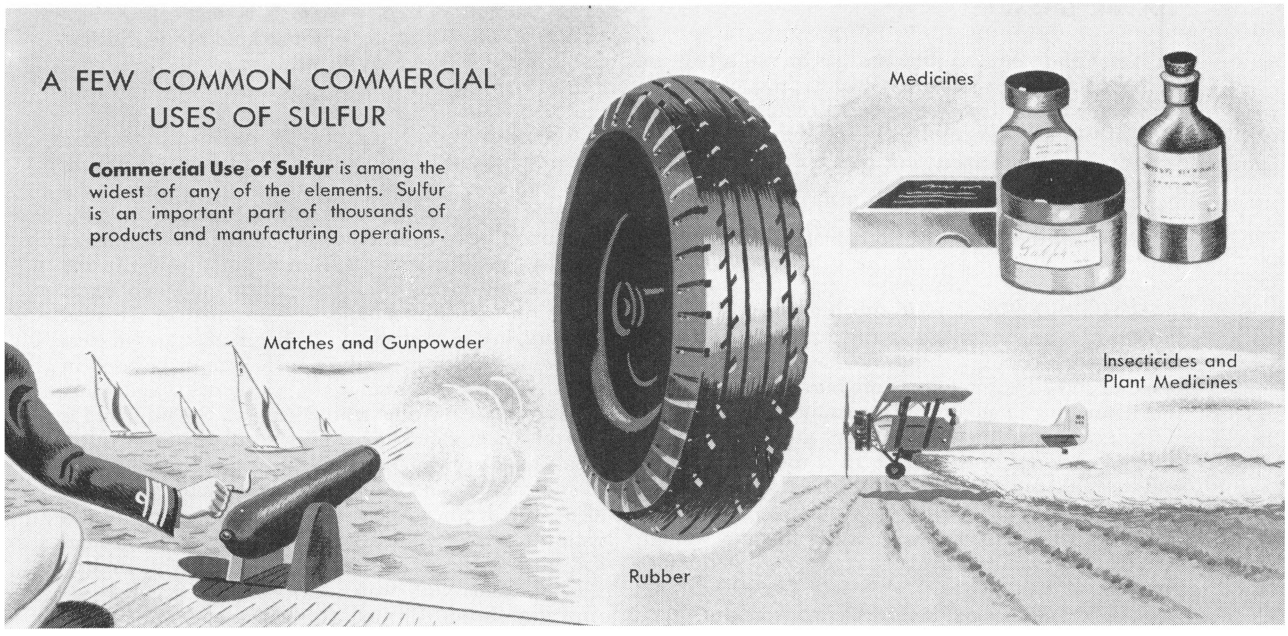
SULFIDE is a group of compounds of sulfur with some other elements, usually metals. All sulfides contain the sulfide ion, in which sulfur has the valence of minus 2. The chemical symbol for this ion is S^{--}.

Sulfides are important in chemistry and industry. Hydrogen sulfide, a poisonous gas, is used in the laboratory to test for various metals. Hydrogen sulfide in the air tarnishes silver. Carbon disulfide is a solvent of rubber and sulfur, and a local anesthetic. It has been used to kill animal and insect pests. Deposits of metallic sulfides are important ores of the metals. Examples are the sulfides of zinc (zinc blende), lead (galena), mercury (cinnabar), and copper (chalcocite). Several colored sulfides are pigments in paints.

See also CARBON DISULFIDE; HYDROGEN SULFIDE.

SULFONAMIDES. See SULFA DRUGS.

SULFUR (chemical symbol, S) is a solid, nonmetallic element. It has an atomic number of 16 and an atomic weight of 32.064. It is found in many vegetables, such as onions, cabbage, and horseradish. It is necessary for the growth of plants and animals. Eggs also contain sulfur. In the mineral world, sulfur is found in large quantities both in a pure state and in combination with other substances. Sulfur occurs in a pure state in places where there are volcanoes. It combines with metals to form certain valuable metal ores such as *sphalerite*, *galena*,



cinnabar, and *stibnite*. *Gypsum*, or *calcium sulfate*, is an important mineral that contains sulfur.

Forms of Sulfur. Sulfur comes in three forms, known as *allotropic* forms (see ALLOTROPY). Allotropic forms of an element have different physical forms. But they have the same chemical properties and are in the same state of matter. Sulfur comes in rhombic crystals, monoclinic crystals, and amorphous, or plastic, form. The *rhombic* crystals have three unequal axes, each of which is at right angles to the other. *Monoclinic* crystals are very transparent and are shaped like prisms. That is, two of the axes are at right angles with the third axis. *Amorphous*, or *plastic*, sulfur that may be formed by dropping molten sulfur into cold water, readily changes to the crystalline, rhombic form. Ordinary lump sulfur occurs in either rhombic or monoclinic crystals. It is pale yellow in color, though sulfur may sometimes be greenish, brownish, or reddish.

Properties of Sulfur. Sulfur is brittle and has almost no taste. When it is rubbed or melted, it gives off a "rotten egg" odor. It does not dissolve in water but dissolves readily in carbon disulfide.

Rhombic sulfur melts at 112.8° C (235° F.) and monoclinic melts at 119.0° C (246.2° F.). When heated above its melting point, sulfur becomes syrupy or a solid. When the temperature reaches about 250° C (482° F.), the sulfur becomes so thick that it cannot be poured from the vessel. Above 250° C, the sulfur changes back into a liquid. The boiling point of sulfur is 444.6° C (832° F.). When it boils it gives off a yellowish-brown vapor. This vapor *sublimes* (condenses) into fine yellow grains of powder known as *flowers of sulfur*. The roll sulfur that is used commercially is made by pouring liquid sulfur into cylinder-shaped molds to harden.

Sulfur ignites at a low temperature and burns very quickly. It burns in air with a pale-blue flame and gives off *sulfur dioxide*, a colorless gas. When sulfur dioxide is exposed to moist air, it mixes with the moisture in the air and forms *sulfurous acid*. Both sulfur dioxide and sulfurous acid are constantly being formed in the air in cities that burn a large amount of coal and gas.

Sources. Before 1900 almost all sulfur came from Sicily. Today the United States produces much sulfur, chiefly in Texas and Louisiana. Sulfur also is found in Spain, Mexico, Japan, and Italy.

The most common method of mining sulfur is called the *superheated water method*. This method was invented about 1900 by the American scientist Herman Frasch (see MINING [diagram]). By this method, sulfur deposits are heated beyond the melting point, known as *superheating*. Water is superheated under increased pressure so that its boiling point rises above sulfur's melting point. Four pipes, one inside the other, bore into the sulfur deposit. The two outside pipes force the hot water into the sulfur, causing the sulfur to melt. The fourth (innermost) pipe sends down compressed air into the deposit. This causes the melted sulfur to form a froth. The increased air pressure forces the froth up the third pipe. All other substances that have a higher melting point remain. Sulfur of about 99 per cent purity is obtained in this way. The frothy sulfur is sprayed into bins and allowed to dry thoroughly in the open air. By another and newer method, the sulfur cools and solidifies on a conveyer belt moving over shallow tanks of cold, running water.

Sulfur may be recovered in acid form from gases at metallic sulfide smelters. Sulfur as an element may be obtained from some natural gases and from refinery gas.

Uses. Sulfur has many commercial uses. Pure sulfur is used to make up a group of valuable substances known as *sulfur compounds*. These sulfur compounds include sulfuric acid, the sulfite salts, and sulfur dioxide. Sulfur mixes with saltpeter and charcoal to form gunpowder, and is used to some extent in the manufacture of matches. For the farm, sulfur is used in the manufacture of fertilizers, and in preparations that destroy in-

sects and plant pests. Sulfur also has an important use in the making of paper pulp, which is produced by the action of calcium bisulfite on wood cellulose. Sulfur is used in various medicines and is considered helpful in certain skin diseases. Photographers use a sulfur compound, *sodium thiosulfate*, to fix photographic images after development. GEORGE L. BUSH

Related Articles in WORLD BOOK include:

Brimstone	Sulfate	Sulfur Dioxide
Sulfa Drugs	Sulfide	Sulfuric Acid

SULFUR DIOXIDE, *dy AHK side*, is a colorless, poisonous gas with a sharp odor of burning sulfur. Polluted air in cities often contains sulfur dioxide, which can damage the lungs. The gas forms from burning coal or other fuel containing large amounts of sulfur.

Industries combine sulfur dioxide with water to make sulfurous acid (H_2SO_3). This acid is used as a bleach and as a food preservative. Industries also combine sulfur dioxide with oxygen to make sulfur trioxide (SO_3). Sulfur trioxide combines with water to form sulfuric acid (H_2SO_4). Sulfur dioxide changes to a liquid under pressure, or when cooled to $-10°$ C ($+14°$ F.). In liquid form, sulfur dioxide serves as a refrigerant.

Sulfur dioxide is found in volcanic gases and mineral waters. Manufacturers make it by burning sulfur or by heating metallic sulfur compounds. It is made in the laboratory by mixing acids with sulfite compounds. Sulfur dioxide has the chemical formula SO_2. It is about twice as heavy as air. OTTO THEODOR BENFEY

See also ENVIRONMENTAL POLLUTION (Causes); SULFURIC ACID.

SULFURIC ACID (chemical formula, H_2SO_4), is a heavy, oily liquid that is strongly corrosive. Alchemists used to call it *oil of vitriol* (see ALCHEMY). Chemists classify sulfuric acid with the mineral acids because it comes from sulfur, a mineral. Some sulfuric acid contains excess amounts of *sulfur trioxide*. It is then called *oleum* or *fuming sulfuric acid*, because this kind of sulfuric acid fumes when exposed to the air.

Uses

Almost every manufactured article in common use depends in some way on sulfuric acid for its production.

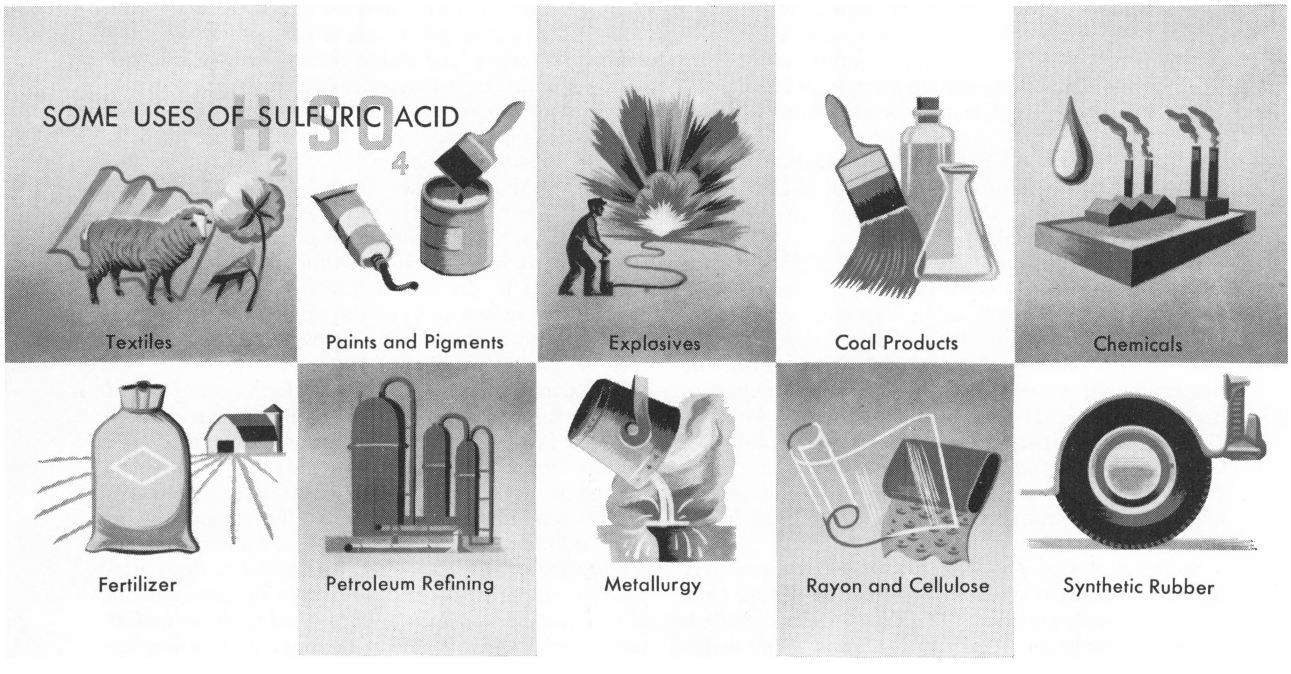
In Industry, the largest use of sulfuric acid is in the manufacture of fertilizers. Its second largest use is in the refining of petroleum, especially in the purification of gasoline. Sulfuric acid plays an important part in the manufacture of all other mineral or inorganic acids. Large quantities of sulfuric acid are used in the steel industry, in the production of other metals, and in electroplating. Along with nitric acid, it must be used in producing TNT, nitroglycerin, picric acid, and other explosives (see TNT; NITROGLYCERIN). Sulfuric acid is also used in automobile batteries (see BATTERY).

In Chemistry. Sulfuric acid plays an important part in the production of many organic chemicals. Ethyl alcohol and other alcohols are made from petroleum with the help of sulfuric acid. When ethylene, a chemical obtained from petroleum, is treated with sulfuric acid, it reacts with water to form ethyl alcohol (see ALCOHOL [Ethyl Alcohol]; ETHYLENE). Substances derived from benzene react with sulfuric acid to form sulfonates, which are widely used in detergents (see DETERGENT AND SOAP). Aromatic compounds such as toluene react with nitric and sulfuric acids to form nitro compounds. Some nitro compounds are useful as explosives. For example, TNT is a tri*nitro*toluene. Nitro compounds are also needed to prepare dyes and other chemicals.

Chemical Action

Sulfuric acid is a strong acid and has a high boiling point. Because of this, it is useful in making other acids.

Sulfuric acid dissolves many metals and metal oxides to form sulfate salts. Metal sulfates thus formed have



many uses in industry. For example, barium sulfate is used in the manufacture of paper.

Water can be mixed with sulfuric acid. But the mixing must be done carefully because of the great amount of heat released when the liquids mix. When concentrated sulfuric acid is to be diluted with water, the acid is always added to the water. If the water is added to the acid, dangerous spattering results.

Sulfuric acid combines quickly with water. Because of this, chemists often use it as a drying and dehydrating agent. An experiment can be performed with sulfuric acid and cane sugar. If the acid is poured on the sugar, the sugar becomes hot, swells, and finally turns into a black, spongy mass. This reaction takes place because the sulfuric acid removes all the water from the sugar. What is left is a mass of black carbon.

Making Sulfuric Acid

Large amounts of sulfuric acid are produced every year in the United States. Manufacturers usually use the lead-chamber process or the contact process. In each process, sulfur dioxide must first be obtained either by burning sulfur or by roasting metallic sulfides.

The Lead-Chamber Method. A mixture of sulfur dioxide, air, steam or water, and an oxide of nitrogen are put in lead-lined chambers. Chemical action of the ingredients with steam produces sulfuric acid.

The Contact Method is a newer process in which a mixture of sulfur dioxide and air is converted to sulfur trioxide. This is done by passing the gas mixture through a heated tube that contains a catalyst (see CATALYSIS). The sulfur trioxide produced combines with water to form sulfuric acid. However, this reaction occurs violently because it produces a large amount of heat. To control the reaction, manufacturers first dissolve the sulfur trioxide in concentrated sulfuric acid. Sulfuric acid produced by this method is more highly concentrated and more pure than that produced by the lead-chamber process. JAMES S. FRITZ

See also ACID; BLEACHING; SULFATE.

SULGRAVE MANOR is an estate in Northamptonshire, England, which is regarded as the home of George Washington's ancestors. The Washington family owned it from 1539 to 1610, when Robert Washington and his son Lawrence sold it. Lawrence Washington built the manor house in the 1500's. In 1914, the British government bought the house to celebrate 100 years of peace between Britain and the United States. The house is still fairly well preserved. American patriotic societies helped furnish and restore the interior. ALAN K. LAING

SULLA, LUCIUS CORNELIUS (138-78 B.C.), reformed the Roman government. He was the first Roman general to use his army against his political opponents. Later politicians, including Julius Caesar, followed this example.

Sulla was a member of a *patrician* (aristocratic) family. In 88 B.C., he was a *consul* (chief government official) and commander of a Roman army. When Mithridates VI, king of Pontus (in Asia Minor) attacked Roman lands in Asia, the Roman Senate put Sulla in command of an army to fight him. But the Assembly overruled the decision, and voted the command to Gaius Marius. Sulla was driven out of Rome. He returned with his army and drove out Marius, then went to fight Mithridates.

In 87 and 86 B.C., Sulla attacked Athens, an ally of Pontus, and defeated two of Mithridates' armies. When Sulla entered Asia, Mithridates asked for and got peace.

Sulla hurried back to Rome, because Marius and other "popular" leaders had returned and killed many of his supporters. Marius was dead when Sulla returned in 83 B.C., but Sulla fought and won a civil war against Marius' followers. As dictator from 82 to 79 B.C., Sulla reorganized the state. He destroyed the power of the *tribunes* (representatives of the people), and gave the Senate control of Rome. After Sulla retired in 79 B.C., most of his reforms were discarded. HENRY C. BOREN

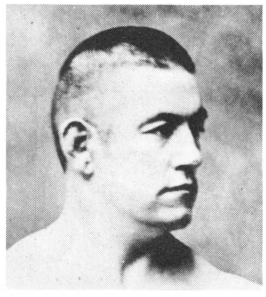
See also MARIUS, GAIUS.

SULLIVAN, ANNE. See KELLER, HELEN ADAMS.

SULLIVAN, SIR ARTHUR SEYMOUR. See GILBERT AND SULLIVAN.

SULLIVAN, JOHN. See NEW HAMPSHIRE (The Revolutionary War).

SULLIVAN, JOHN L. (1858-1918), was a famous bare-knuckle fighter and world heavyweight boxing champion. He won the heavyweight title from Paddy Ryan in 1882 in Mississippi City, Miss., on an eighth-round knockout. Sullivan fought his most famous fight with Jake Kilrain in 1889. They fought 75 rounds (2 hours, 16 minutes) before Sullivan won on a knockout. He lost the championship to Jim Corbett in 1892. He retired in 1905, and appeared on the stage. Sullivan was born in Roxbury, Mass. See also BOXING (picture). LYALL SMITH



Brown Bros.

John L. Sullivan

SULLIVAN, LEON HOWARD (1922-), is a Baptist minister who organizes economic self-help programs for blacks. In 1971, Sullivan became the first black member of the 23-man board of directors of General Motors Corporation. He works to hire and train blacks for jobs at all levels throughout the company.

Sullivan began his self-help projects in the 1950's. He regarded unemployment as the basic cause of black juvenile delinquency. In 1959, he led 400 black ministers and their congregations in starting what turned out to be a three-year boycott of about 30 Philadelphia companies. These firms had refused to hire blacks, but opened many jobs to them as a result of the boycott.

In 1962, Sullivan founded Zion Investment Associates. He persuaded members of his Zion Baptist Church —and later other blacks—to give this corporation $10 a month for three years to establish black businesses. The corporation built and manages an apartment complex, a shopping center, a garment manufacturing company, and other businesses—all in Philadelphia. In 1964, Sullivan founded the Opportunities Industrialization Center (OIC) there to provide training and job placement for minority groups. During its first seven years, OIC trained 65,000 workers and opened centers in 90 United States cities. Sullivan was born in Charleston, W. Va. EDGAR A. TOPPIN

SULLIVAN, LOUIS HENRI

SULLIVAN, LOUIS HENRI (1856-1924), ranks with Frank Lloyd Wright and Henry Hobson Richardson as one of America's greatest architects. Sullivan's influence comes from the quality and originality of his designs and his perceptive writings on architectural theory. He was a leader of the Chicago school of architecture.

More than any other architect of the 1800's, Sullivan united the major threads of architecture and engineering with broad theories of nature and social change. Sullivan considered the creation of a building more than a problem of design, a solution of practical needs, or the development of a structural scheme. To him, a building was the expression of a view of man, nature, and society. He used ornament, design, utility, and structure to express his philosophy. Sullivan popularized the phrase "form follows function." Through his buildings and writings, he argued that function meant more than satisfying practical needs or arriving at a logical structure. Sullivan declared that a building should be *organic*—that is, it should be an expression of man's view of nature and society.

Sullivan was born in Boston. He joined the firm of Chicago architect Dankmar Adler in 1879 and became a full partner two years later. Sullivan and Adler seem to have had an ideal relationship. Sullivan was responsible for the design of buildings, and Adler concentrated on solving engineering problems and obtaining clients. Their Chicago Auditorium Building (1886-1889) is considered Sullivan's first original design. In 1890, Sullivan designed the Wainwright Building in St. Louis. It was one of the first buildings to clearly express the vertical thrust of a skyscraper.

Sullivan and Adler separated in 1895, and Sullivan's business success as an architect declined rapidly. After about 1900, he was able to obtain only a few commissions for small Midwestern banks and office buildings. Despite their size, these buildings rank among Sullivan's finest creations. During his later years, Sullivan concentrated much of his effort on writing. His most notable works include *Kindergarten Chats* (1901-1909) and *Autobiography of an Idea* (1924). DAVID GEBHARD

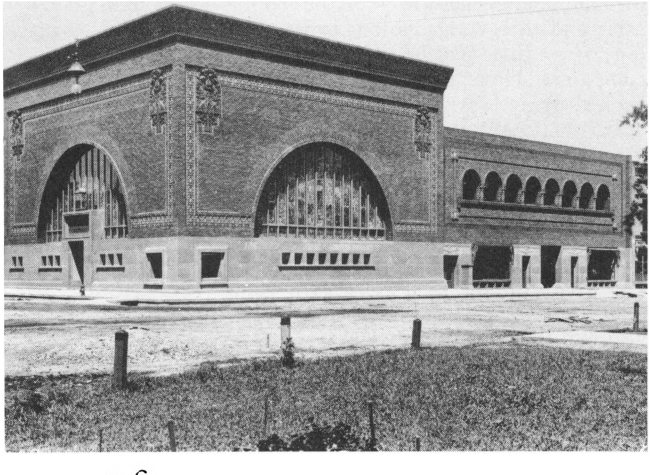
See also ADLER, DANKMAR; ARCHITECTURE (The 1800's [picture]).

SULLIVAN, MARK (1875-1952), was an American author, newspaper columnist, magazine editor, and writer for more than 60 years. He became best known for his syndicated political column, begun in the middle 1920's. He also wrote *Our Times* (1926-1936), a six-volume chronicle of American history. Sullivan, an Irish farmer's son, was born in Avondale, Pa. He began his magazine career on the *Ladies' Home Journal* in 1904. Sullivan joined *Collier's* magazine in 1906, and became its editor in 1914. JOHN TEBBEL

Elmslie

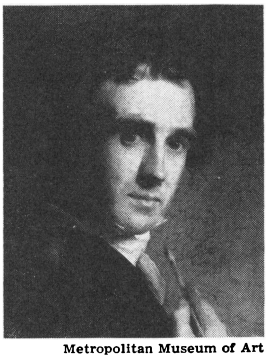
Louis Sullivan, ***left,*** **was one of America's greatest architects. His Wainwright Building,** ***right,*** **in St. Louis was one of the first skyscrapers. Sullivan's last works included several small Midwestern banks and office buildings, among them the National Farmers' Bank,** ***below,*** **in Owatonna, Minn.**

Chicago Architectural Photo Co.



Richard Nickel

Museum of Fine Arts, Boston



Metropolitan Museum of Art

The Torn Hat by Thomas Sully, *above*, is a study of this American artist's son. The winsome face, torn hat, and simple charm of the boy have made this a favorite among paintings of children. Sully painted the self-portrait, *left*, in the early 1800's.

SULLY, DUKE OF. See FRANCE (The Age of Absolutism).

SULLY, THOMAS (1783-1872), an American painter, was noted for his elegant and refined portraits. Sully painted delicate, fragile portraits of women that glowed with life. His portraits of men were elegant but sturdier. Portraits by him appear in the ADAMS, JOHN QUINCY, and HENRY, PATRICK articles.

Sully was born in Horncastle, England, and came to America when he was 9. He began studying painting when he was about 12. Sully moved to New York City in 1806, then settled permanently in Philadelphia in 1808. He visited London in 1809 and 1810, and met the painters Benjamin West and Sir Thomas Lawrence, who greatly influenced his style. Sully enjoyed great success after that and was sent to London in 1838 to paint a portrait of Queen Victoria. FREDERICK A. SWEET

SULLY-PRUDHOMME, *syoo LEE pryoo DAWM*, **RENÉ FRANÇOIS ARMAND** (1839-1907), a French poet, won the 1901 Nobel prize for literature. His early collections of verse, including *Les Épreuves* (1866) and *Les Solitudes* (1869), deal with the sufferings of love. His later poems express the conflicts of science and religion. He also wrote several books on philosophy and psychology. He was born in Paris. As a young man, he studied engineering. HASKELL M. BLOCK

SULPHUR. See SULFUR.

SULPICIAN SEMINARY OF THE NORTHWEST. See UNIVERSITIES AND COLLEGES (table).

SULTAN is a title of honor given to Moslem princes and rulers. The word means *sovereign*, but in ancient days it meant merely someone who was stern and mighty. The title has been used since about A.D. 900. The ruler of old Turkey was the greatest of the sultans. Today, many sultans have wealth, but few have the power of the ancient princes. See also SERAGLIO. SYDNEY N. FISHER

SULU ARCHIPELAGO. See PHILIPPINES (The Islands).

SULU SEA is also called the SEA OF MINDORO. It lies between the Philippine Islands and Borneo. The Sulu Sea is surrounded by the Visaya Islands on the northeast, Borneo on the southwest, and the Sulu Islands on the southeast. Straits connect the Sulu Sea with the South China Sea and the Pacific Ocean. The sea has an average depth of 14,600 feet (4,450 meters). Near the western coast of Mindanao, it is more than 16,000 feet (4,880 meters) deep. For location, see PHILIPPINES (color map). F. G. WALTON SMITH

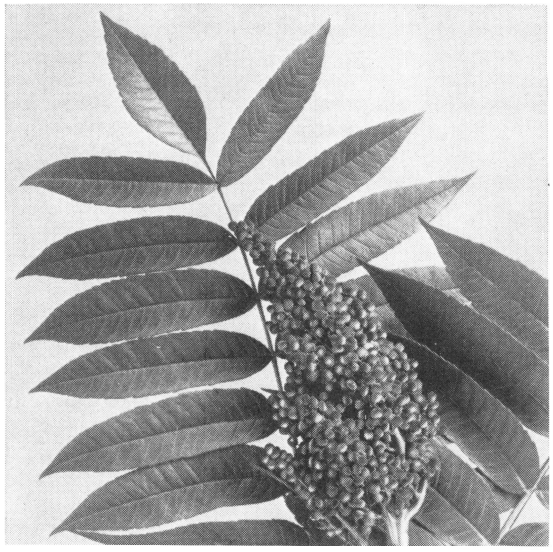
SULZBERGER, ARTHUR HAYS (1891-1968), an American newspaperman, was publisher of *The New York Times* from 1935 to 1961. He succeeded his father-in-law, Adolph S. Ochs. Sulzberger carried on the great tradition of that influential newspaper. Under his direction, the *Times*' staff became the largest in the world. Sulzberger championed the cause of free and responsible journalism. Born in New York City, he joined The *Times* in 1918. He continued as chairman of the board after he retired as publisher in 1961. ALVIN E. AUSTIN

SUMAC, *SHOO mack*, or *SOO mack*, or SUMACH, is a group of about 120 kinds of small trees or shrubs that grow in temperate regions. Many have commercial uses.

Common Sumacs. One of the best known of the North American sumacs is the *staghorn sumac*. It grows from southern Canada to Georgia and Mississippi. It is an attractive flat-topped tree, growing 30 to 35 feet (9 to

Sumac Has Narrow Leaves and Clusters of Berries.

J. Horace McFarland



11 meters) high. The tree bears small, greenish flowers and tiny red berries. Its fernlike leaves are velvety dark green above, and pale beneath. In autumn, the leaves turn scarlet, orange, and purple. The forked branches of immature trees have a velvety down. The berry clusters and leafstalks are hairy. The brittle wood has no practical use.

The *dwarf*, *black*, or *mountain sumac* is as pretty as the staghorn. It grows throughout the eastern United States and from the Mississippi River west to the Rockies. The dwarf sumac is usually a shrub, although in the Tennessee and North Carolina mountains it grows as tall as the staghorn. Its leaves contain much tannin and are used in tanning leather. They also provide a yellow dyestuff. The *smooth-leaved sumac*, which usually grows only about 3 feet (91 centimeters) high, is found east of the Rocky Mountains, from Arizona to British Columbia. The unripe summer berries make a refreshing drink that tastes something like lemonade. Some American Indians used the bark, leaves, and berries of the smooth-leaved sumac as a medicine.

Poisonous Sumacs have berries that hang in drooping clusters. The red berries of the harmless sumacs are in dense, erect clusters. The *poison sumac*, also called *poison elder*, has white berries. It grows in swampy land from New England to Minnesota and from Georgia to Texas. *Poison ivy* and *poison oak* have white berries. They are beautiful in autumn, with scarlet and orange foliage. The *varnish tree*, also called the *lacquer tree*, and the *wax tree* grow in Japan, China, and the Himalaya. The lacquer tree provides fine lacquer, and the wax tree is used in making candles.

Scientific Classification. The sumacs belong to the cashew family, *Anacardiaceae*. They make up the genus *Rhus*. The staghorn sumac is species *R. typhina*. The shining sumac is *R. copallina;* the smooth is *R. glabra;* and the poison is *R. vernix*. J. J. LEVISON

See also POISON IVY.

SUMATRA, in Indonesian, SUMATERA. See INDONESIA (The Islands).

SUMBA. See INDONESIA (table: Chief Islands).

SUMBAWA. See INDONESIA (table: Chief Islands).

SUMER, *SOO mur*, was a region settled before 3500 B.C. in the lower part of Mesopotamia (now Iraq). The people who settled it probably came from the highlands of present-day Turkey or Iran. They are often pictured with long skirts, shaven heads, and sometimes with beards. Scholars do not know the exact origin of their racial or language group.

The Sumerians developed a brilliant civilization in Mesopotamia. Their small settlements grew into cities and city-states. The more powerful city-states conquered their neighbors and created small kingdoms, including Kish, Lagash, Nippur, Umma, Ur, and Uruk (Warka).

The Sumerians developed an economy based on farming. They built a great network of irrigation canals to water their fields, and grew barley, date palms, wheat, and many kinds of vegetables. They used domestic animals such as donkeys, goats, and sheep. Their society included priests, soldiers, traders, freemen, and slaves.

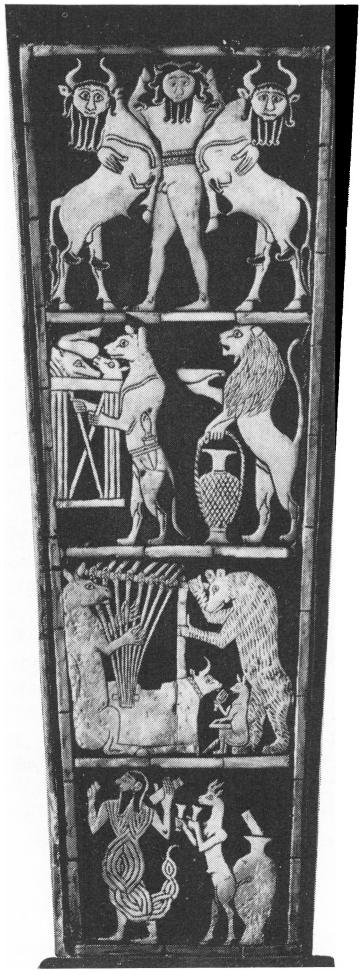
The Sumerians invented a system of writing, probably before 3000 B.C. Their *cuneiform*, or *wedge-form*, writing became one of the most important ancient systems of writing (see CUNEIFORM). Thousands of clay tablets and inscriptions that have been preserved tell about the Sumerian government, law, business, and religion. They also show that the Sumerians had some knowledge of mathematics, astronomy, and medicine.

The Sumerians built great temples and palaces in their cities. Skilled craftsmen made beautiful art objects and household equipment out of copper, gold, silver, and stone. They wove fine cloth, and made armor, chariots, spears, and swords for their armies. Many industries were identified with specific towns. Ur was known for its metalworks and Umma for its textiles.

Much of the Sumerian culture was absorbed by Se-

An Ancient Sumerian Grave yielded the **headdress** and jewelry, *left*, of **Queen** Shub-ad, who lived **about** 5,500 years ago. The **well preserved, pictorial shell plaque,** *right*, came from the **grave of** a Sumerian king who **reigned** about 3500 B.C.

University Museum, Philadelphia



mitic invaders who moved into Mesopotamia and slowly took over the region. By 2000 B.C., the Sumerians had lost political power, but they furnished the base on which the impressive Babylonian and Assyrian civilizations developed. JOHN WILLIAM SNYDER

See also ASSYRIA; BABYLONIA; UR; HARP (picture).

SUMMA CUM LAUDE. See DEGREE, COLLEGE.

SUMMER is the warmest season of the year. The Northern Hemisphere, the northern half of the earth, has summer weather during late June, July, August, and early September. Summerlike days sometimes occur in mid-autumn (see INDIAN SUMMER). In the Southern Hemisphere, summer weather lasts from late December until early March. For dates of the first day of summer and information about the position of the earth and sun during summer, see SEASON.

In summer, warm southern winds carry moisture north from the Gulf of Mexico to central and eastern North America. These winds can bring warm, humid weather to much of the region east of the Rocky Mountains and as far north as southern Canada. Thunderstorms often develop in and along the northern boundary of this warm, moist air. The highest summer temperatures usually occur in the middle of the continent. JOHN E. KUTZBACH

See also JUNE; JULY; AUGUST; SEPTEMBER; DOG DAYS.

SUMMERSIDE, Prince Edward Island (pop. 9,439), is a port and a center for breeding silver foxes. It stands on Bedeque Bay, about 5 miles (8 kilometers) south of Malpeque Bay, which is famous for fine oysters (see PRINCE EDWARD ISLAND [map]). Summerside is in the richest farmlands of the island. It was once called Green's Shore, but was renamed because it lies on the warmer, or "summer," side of the island. Large amounts of farm and fish products are shipped from Summerside. The Canadian National Silver Fox Breeders' Association and the Dominion Fox Experimental Station headquarters are there. Summerside has a council-manager form of government. FRANK MACKINNON

SUMMIT CONFERENCE, or SUMMIT MEETING, is a meeting of two or more heads of state. It usually refers to a conference attended by Communist and Western democratic leaders. A 1955 conference in Geneva, Switzerland, is regarded as the first summit conference. See also COLD WAR (The Spirit of Camp David).

SUMMONS is an order *served* (delivered) by a sheriff or some other officer of a court. The summons notifies the person named in it that a complaint has been made against him, and that he must come to court to answer it. In some jurisdictions, the plaintiff's attorney or the court clerk may issue the summons. A summons also may be issued by other governmental agencies, such as congressional committees. See also SUBPOENA; WRIT.

SUMNER, CHARLES (1811-1874), was an American statesman and antislavery leader. After the Civil War, he advocated treating the South harshly. He led the Senate's opposition to President Abraham Lincoln's moderate plans for reconstruction. Later, he also opposed President Andrew Johnson's plans.

Sumner was born in Boston and was educated at Harvard University. He first won attention as a lecturer on peace and abolition. He was elected United States senator from Massachusetts in 1851. In the Senate, he vigorously attacked the South. In 1856, Sumner made a Senate speech which included several sneering references to Senator Andrew P. Butler of South Carolina. Three days later, Representative Preston S. Brooks (1819-1857), Butler's nephew, attacked Sumner in the Senate, beating him senseless.

Summer helped found the Republican Party, and during the Civil War was one of the most powerful men in the Senate. He favored freeing the slaves and giving them the right to vote. He opposed President Ulysses S. Grant's plan for annexing Santo Domingo (see GRANT, ULYSSES S. [Foreign Relations]). W. B. HESSELTINE

SUMNER, JAMES BATCHELLER (1887-1955), an American biochemist, crystallized the first enzyme (see ENZYME). He extracted the enzyme urease from the jack bean, and converted the crude material into pure crystals. His success stimulated John Howard Northrop to crystallize other important enzymes, and Wendell Meredith Stanley to crystallize the first virus. The three men shared the 1946 Nobel prize in chemistry. Sumner was born in Canton, Mass. HERBERT S. RHINESMITH

SUMNER, WILLIAM GRAHAM (1840-1910), was a noted American sociologist and economist in the late 1800's. His ideas about society reflected biologist Charles Darwin's findings about evolution.

Sumner believed the phrase "survival of the fittest" applied to man in society as well as to animals in nature. He believed that hard work results in wealth, and that poverty is the result of bad habits and laziness. He argued that reformers who tried to change society or to aid the poor were dangerous. This philosophy became known as Social Darwinism.

Sumner was born in Paterson, N.J. He taught at Yale University. His most important book, *Folkways* (1907), was a study of society. CHARLES FORCEY and LINDA FORCEY

SUMP. See GASOLINE ENGINE (Lubrication System).

SUMPTUARY LAW, *SUHMP chu EHR ee.* The word *sumptuary* comes from a Latin word which means *expenditure.* In ancient Greece and Rome, laws limited the amount of money that anyone could spend on private luxuries. Laws of this kind were called *sumptuary laws.*

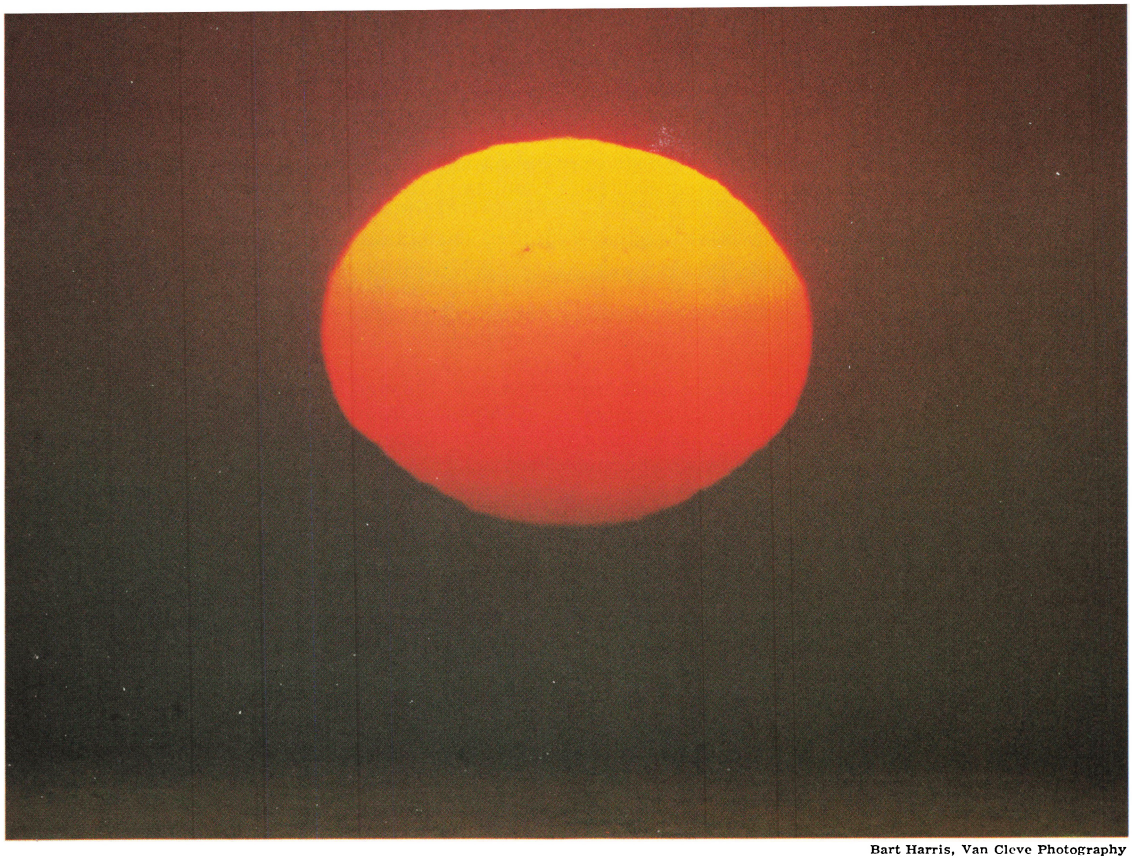
Similar laws have been common at various times in England, France, Scotland, Spain, and Italy. From the days of Edward III (1327-1377) until the Reformation in the early 1500's, the English Parliament restricted the number of courses of a meal to two, except on holidays. It also regulated the amount that members of each class of society could spend on clothes. ERWIN N. GRISWOLD

See also BLUE LAWS; PROHIBITION.

SUMTER, S.C. (pop. 24,555), is the county seat and marketing center of Sumter County, which is a leading South Carolina farming and lumbering region. The city lies about 40 miles (64 kilometers) east and south of Columbia (see SOUTH CAROLINA [political map]). The chief industries include woodworking; the manufacture of furniture, barrels, concrete blocks, and bricks; steel fabrication; and machinery making. Sumter is a large livestock and turkey market. Founded in 1785, Sumter was named for Brigadier General Thomas Sumter, the *Gamecock* of Revolutionary War fame. His home is nearby. Shaw Air Force Base stands near the city. Sumter has a council-manager government.

SUMTER, FORT. See FORT SUMTER.

SUMTER, THOMAS. See SOUTH CAROLINA (History); SUMTER.



Bart Harris, Van Cleve Photography

The Sun Is More Important to Man Than Any Other Object in the Sky, though it is only one of billions of stars in the universe. All life on the earth—man, animals, and plants—depends on the heat, light, and other kinds of energy given off by the sun.

SUN

SUN is a huge, glowing ball of gases at the center of the solar system. The earth and the other eight planets travel around it. The sun is only one of billions of stars in the universe. As a star, there is nothing unusual about it. But the sun is more important to man than any other star. Without the heat and light of the sun, there could be no life on the earth.

The *diameter* (distance through the center) of the sun is about 865,000 miles (1,392,000 kilometers), about 109 times the diameter of the earth. Because the sun is about 93 million miles (150 million kilometers) from the earth, it does not appear larger than the moon. But the sun's diameter is 400 times as large as that of the moon. The sun is also almost 400 times farther from the earth than is the moon.

If the sun were the size of a skyscraper, the earth would be the size of a man. The moon would be the size of a cocker spaniel standing next to the man. Jupiter, the largest planet, would be the size of a small building. The nearest star also would be about the size of a skyscraper. But it would be about 7 million miles (11 million kilometers) away.

The sun is nearer the earth than is any other star. For this reason, scientists study it to learn about stars much farther away. The visible surface of the sun consists of hot gases that give off light and heat. Only about one two-billionth of the sun's light and heat reaches the earth. The rest is lost in space.

The temperature of any place on the earth depends on the position of the sun in the sky. The temperature greatly affects the weather of a region. For example, tropical regions near the equator have a hot climate because the sun shines almost directly overhead at noon. Regions near the North and South poles have a cold climate because the sun never rises far above the horizon.

The Egyptians, Greeks, and many other ancient peoples thought the sun was a god. They worshiped the sun, made offerings to it, and built temples to honor it. Many early beliefs about the sun began when man tried to explain the sun's movement across the sky.

Today, man knows he must have the sun as a source of heat, light, and other kinds of energy. All life on the earth—man, animals, and plants—depends on this energy from the sun. Plants use sunlight to make their own food and in the process give off oxygen. Man and animals eat the plants and breathe in the oxygen. In turn, man and animals breathe out carbon dioxide, which plants combine with energy from sunlight and water from the soil to produce more food.

Scientists estimate that the sun and the rest of the objects in the solar system are about 4,600,000,000 years old. They believe that the sun will continue to be a source of man's energy needs for at least another 5 billion years.

The contributor of this article is A. G. W. Cameron, Professor of Space Physics at the Belfer Graduate School of Science at Yeshiva University.

Important Facts About the Sun

THE SUN AT A GLANCE

Distance from the Earth: *Shortest*—about 91,400,000 miles (147,100,000 kilometers); *Greatest*—about 94,500,000 miles (152,100,000 kilometers); *Mean*—about 93 million miles (150 million kilometers). Sunlight takes about 8 minutes and 20 seconds to reach the earth, traveling at 186,282 miles (299,792 kilometers) per second.

Diameter: About 865,000 miles (1,392,000 kilometers), approximately 109 times that of the earth.

Volume: About 1,300,000 times that of the earth.

Mass: 99.8 per cent of the mass of the solar system; about 333,000 times that of the earth.

Temperature: *Surface*—about 10,000° F. (about 5500° C); *Center*—about 27,000,000° F. (about 15,000,000° C).

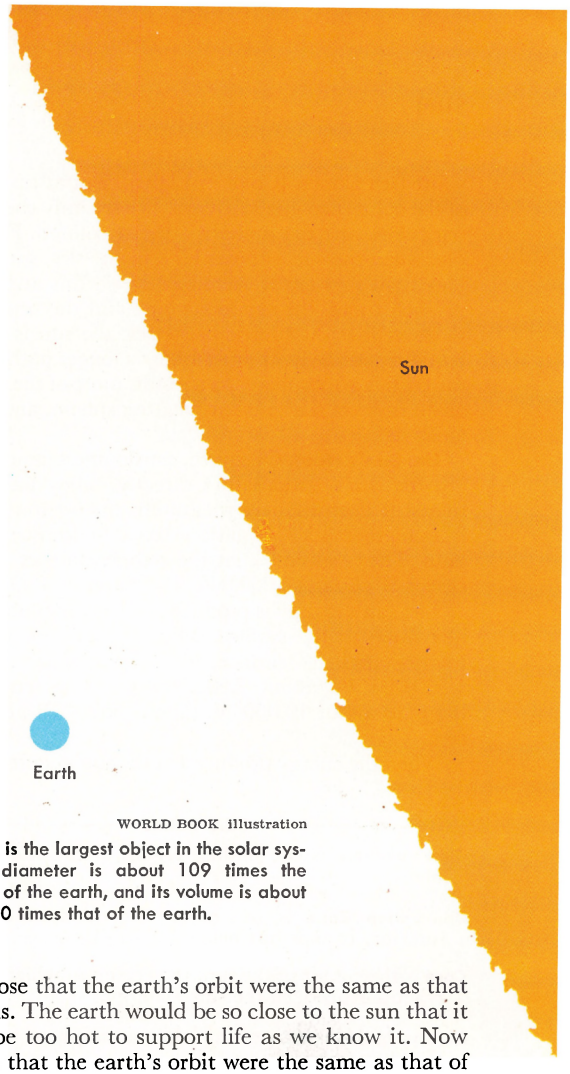
Age: About 4,600,000,000 years.

Rotation Period: About 1 month.

Revolution Period in the Milky Way: About 200 million years.

Chemical Makeup: Hydrogen, about 75 per cent; helium, almost 25 per cent; at least 70 other elements make up the remaining 1 to 2 per cent.

Density: *Convection Zone*—about $\frac{1}{10}$ that of water; *Radiative Zone*—about equal to that of water; *Core*—about 100 times that of water.



WORLD BOOK illustration

The Sun is the largest object in the solar system. Its diameter is about 109 times the diameter of the earth, and its volume is about 1,300,000 times that of the earth.

The Size of the Sun. The sun is closer to the earth than is any other star, and so it looks larger than other stars. Compared with the planets in the solar system, the sun is large. For example, the diameter of the sun is about 865,000 miles (1,392,000 kilometers). This distance is about 109 times the diameter of the earth. It is also nearly 10 times the diameter of Jupiter, the largest planet, and about 400 times the diameter of the moon.

Compared with other stars, the sun is only medium-sized. In fact, it is one of many stars that astronomers call *yellow dwarfs*. Some stars have a diameter 10 times as small as that of the sun. Other stars have a diameter as large as 1,000 times that of the sun. Astronomers call these huge stars *red giants*. One red giant, Betelgeuse, has a diameter over 350 times that of the sun. If the sun grew to be the size of Betelgeuse, it would swallow up the planets Mercury, Venus, Earth, and Mars.

From the earth, the sun looks like a circle. Astronomers often use the term *disk* for the part of the sun that can be seen from the earth. Some astronomers have measured the disk and found that it is slightly flattened in some places. But other astronomers are not certain how correct these measurements are.

Distance to the Sun. The earth's distance from the sun varies from about 91,400,000 to 94,500,000 miles (147,100,000 to 152,100,100 kilometers). This distance varies because the earth travels around the sun in an orbit that has an *elliptical* (oval) shape. The average distance between the earth and the sun is about 93 million miles (150 million kilometers).

Suppose that the earth's orbit were the same as that of Venus. The earth would be so close to the sun that it would be too hot to support life as we know it. Now suppose that the earth's orbit were the same as that of Mars. The earth would be so far away from the sun that it would probably be too cold to support anything but the sturdiest and simplest forms of life.

Light travels at a speed of 186,282 miles (299,792 kilometers) per second. Light from the sun takes about 8 minutes and 20 seconds to reach the earth. When a spacecraft is escaping from the pull of the earth's gravity, it must travel at a speed of 25,000 miles (40,200 kilometers) per hour. If it could keep this speed on a journey to the sun—and not burn up—the trip would take 154 days, or a little over five months.

The Sun's Brightness. The light and heat of the sun come from its surface. The amount of light and heat stays fairly constant, so that the actual brightness of the sun changes little. The changes in brightness that seem to take place result from weather conditions in the earth's atmosphere. These conditions affect the amount of sunlight that reaches any particular place on the earth. Sometimes a small increase in brightness may result from eruptions of gases on the sun's surface. Most of these eruptions, called *flares*, last from 10 minutes to an hour. But any changes in the total brightness of the sun caused by flares are not visible to the naked eye.

Sunlight contains all the colors of the rainbow. These colors blend to form white light, and so sunlight is

white (see COLOR [Color in Light]). But at times, some of the colors become scattered. We see only the remaining colors, and the sunlight appears colored. For example, when the sun appears high in the sky, some of the blue light rays are scattered in the earth's atmosphere. At such times, the sky looks blue and the sun appears to be yellow. At sunrise or sunset, the sun is near the horizon and the light must follow a longer path through the earth's atmosphere. As a result, more of the blue and green rays are scattered in the atmosphere, and the sun looks red.

The Sun's Heat. Of course, astronomers cannot measure the sun's temperature directly. They have determined it from indirect measurements on sunlight and from mathematical equations based on known physical laws. They estimate that the temperature at the sun's center is about 27,000,000° F. (about 15,000,000° C).

The sun's energy is produced at its center and gradually flows to the surface. Midway between the sun's interior and its surface, the temperature is about 4,500,000° F. (about 2,500,000° C). The temperature drops to about 10,000° F. (about 5500° C) at the surface.

When the energy produced at the sun's center reaches the surface, it is sent out into space as radiant energy in the form of heat and light. People once thought this heat and light came from something that was burning. Today, scientists know that the sun's light and heat come from *thermonuclear reactions* in the center of the sun. Such reactions occur when lightweight atoms join and form heavier atoms. For more information about these reactions of the sun, see the section of this article called *How the Sun Produces Energy*.

The Sun's Mass makes up 99.8 per cent of the mass of the entire solar system (see MASS). The mass of the sun is about 1,047 times that of Jupiter, the largest planet in the solar system. The sun's mass is about 333,000 times that of the earth.

Because the sun is so large, the force of gravity on it is much greater than on any of the planets (see GRAVITATION). As a result, objects would weigh more on the sun than they would on any planet. A boy who weighs 100 pounds (45 kilograms) on the earth would weigh about 2,800 pounds (1,270 kilograms) on the sun.

Through the force of gravity, the sun controls the orbits of the planets. The force of gravity also pulls the sun's gases toward the center of the sun. If there were nothing to balance the force of gravity on the sun, the sun would collapse. But it does not collapse because its gases are extremely hot. Hot gases have high pressure and try to expand. The pressure of the gases balances the force of gravity. As a result, the sun keeps its size and shape.

What the Sun Is Made Of. About three-fourths of the mass of the sun consists of hydrogen, the lightest known element. Almost a fourth of the sun's mass consists of helium. Scientists discovered this gas on the sun before they found it on the earth. The word *helium* comes from the Greek word *helios*, meaning *sun*.

Of the 105 elements known on the earth, 92 occur naturally. The others are man-made. At least 70 of the 92 natural elements have been found on the sun. But all these elements—except hydrogen and helium—make up only between 1 and 2 per cent of the mass of the sun. Scientists were able to identify the elements on the sun by studying the *spectrum* (pattern of colored lines) of light from the sun (see LIGHT [The Visible Spectrum]).

How the Sun Moves. Like the earth, the sun spins like a top. And, just as the earth revolves around the sun, the sun revolves around the center of the Milky Way galaxy.

The earth takes a day to rotate once on its *axis*, an imaginary line through the North and South poles. But the sun takes about a month to spin around once on the axis through its poles. The regions near the sun's equator rotate once in a few days less than a month. The regions near its poles take a few days more than a month to spin around once. This difference occurs because the sun is a ball of gases. A solid body could not rotate at different rates in different parts.

The earth takes a year to revolve around the sun, but the sun takes about 200 million years to make one revolution around the center of the Milky Way. During this period, the sun travels about 10 billion times as far as the distance between it and the earth.

SUN TERMS

Chromosphere is the middle region of the sun's atmosphere.

Convection Zone is the outermost third of the sun's interior. It ends just below the sun's surface.

Core is the center of the sun, the region in which nuclear reactions produce the sun's energy.

Corona is the region of the sun's atmosphere above the chromosphere.

Disk is the part of the sun that can be seen from the earth.

Flares are bursts of light on the sun's surface. They release huge amounts of the sun's energy.

Granules are small patches of gas that make up the photosphere of the sun.

Photosphere is the visible surface of the sun, the innermost part of the sun's atmosphere.

Prominences are huge, bright arches of gas that rise from the edge of the disk and flow back into the sun.

Radiative Zone is the middle third of the sun's interior.

Solar Radiation is the sun's energy given off as light and heat and in other forms, including radio waves, ultraviolet rays, and X rays.

Solar Wind is the expansion of gases from the sun's corona.

Spicules are streams of gas that shoot up briefly from the chromosphere.

Sunspots are dark patches on the sun's surface that appear and disappear in regular cycles. A complete sunspot cycle consists of two 11-year periods of sunspot activity.

Heat and Light for Life. All life on the earth depends on the sun for heat and light. The steady flow of heat and light from the sun made possible the development of life on the earth. If the sun's heat and light were to vary, life would be endangered. Sometimes the earth would be too hot for life to exist, and sometimes it would be too cold.

The earth's atmosphere helps trap the heat of the sun. The atmosphere lets sunlight through to the surface of the earth. The light warms the earth, but the heat it creates cannot easily pass through the atmosphere into space. As a result, the earth is warmed by the sun. This behavior of the atmosphere is called the *greenhouse effect* because it resembles the action of the glass roof of a greenhouse. The roof lets sunlight in to heat the plants in the greenhouse, but the heat passes back through the roof very slowly.

Life also depends on the sun for food. All living things—both plants and animals—are part of a process called the *food chain*. The food chain starts with green plants. These plants make their own food through the process of *photosynthesis*. During photosynthesis, plants combine energy from sunlight with carbon dioxide from the air and water from the soil to make food. In the process, the plants give off oxygen. Some plants are eaten by animals, which in turn are eaten by larger animals. Man eats both animals and plants. Man and animals breathe the oxygen that the plants release during photosynthesis. They exhale the carbon dioxide that, in turn, is used by plants. See PHOTOSYNTHESIS.

Sunlight can also be harmful. Too much strong sunlight can burn the skin. The sun can seriously injure the eyes if a person looks at it directly.

Weather. Sunlight has a great influence on the earth's weather. For example, it evaporates water from rivers, lakes, and oceans, and this water later falls as rain or snow. When the water is suspended in the atmosphere, clouds appear. They reflect sunlight back into space. Sunlight also comes to the earth at various angles during different seasons. Clouds, and the angle at which sunlight reaches the earth, result in uneven heating of the earth's atmosphere. This uneven heating causes differences in air pressure. Air moves from high pressure areas to low pressure areas, causing wind and changes in weather. See WEATHER.

The Sun As an Energy Source. Until man learned to develop nuclear energy, he depended entirely on sunlight for his energy needs. Plants used sunlight for photosynthesis. Animals ate the plants, and man used both plants and animals for food, clothing, and shelter.

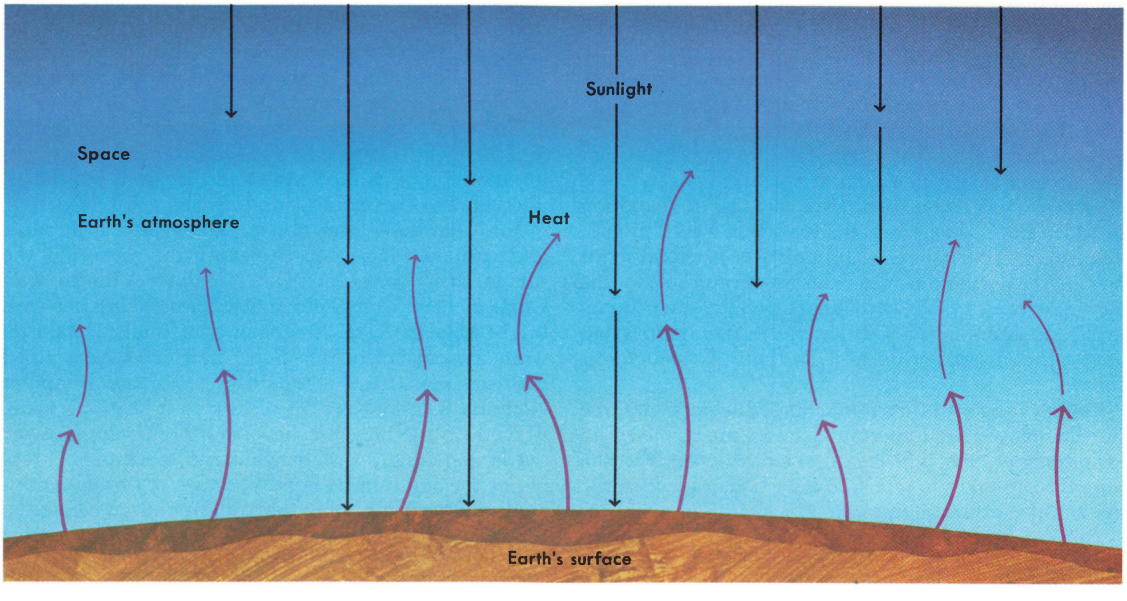
Man also uses the energy in *fossil fuels*—coal, oil, and natural gas. These fuels come from plants and animals that lived millions of years ago. After the plants and animals died, they were buried by soil deposits in swamplands or on the sea floor. By burning coal, and by refining oil and natural gas, man releases energy from the sun that was stored in the fossils millions of years ago.

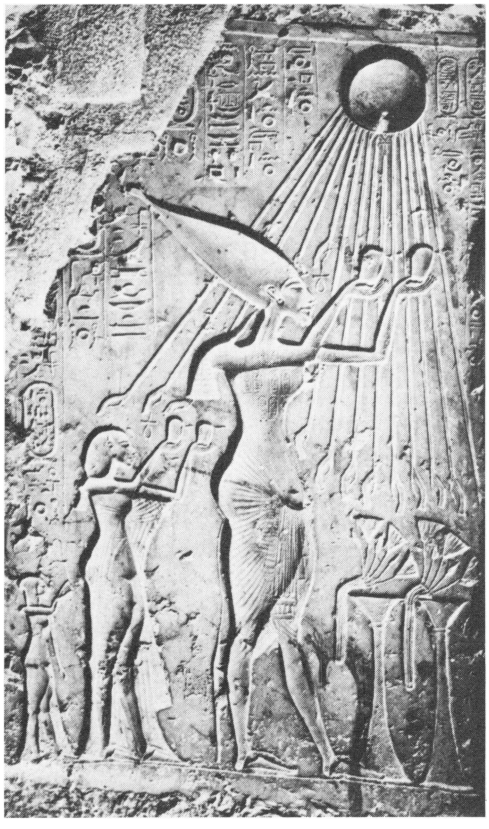
In addition, man uses sunlight for power in other ways. For example, the effects of sunlight cause wind, which man uses to power windmills. Sunlight also evaporates water, which falls as rain. The rain forms rivers. Hydroelectric power plants on the rivers use the power of moving water to generate electricity. Solar furnaces use mirrors to focus sunlight to heat water in boilers. Solar energy cells provide power for artificial satellites and spacecraft. See SOLAR ENERGY.

THE GREENHOUSE EFFECT

The atmosphere of the earth traps heat from the sun, much as does the glass roof of a greenhouse. The roof lets sunlight in to heat the plants, but it prevents much of the heat from getting out. In a similar way, the atmosphere lets sunlight through to the surface of the earth. The sunlight warms the earth, but the heat that is created cannot easily pass back through the atmosphere into space.

WORLD BOOK diagram by Herb Herrick





The Metropolitan Museum of Art, New York City; Design Photographers Int.

Ancient Peoples Built Monuments to the Sun. Most monuments were used to worship the sun, and some also served to tell time. The Egyptians made carvings of the sun and sun worshipers, *left*. The Inca Indians used granite monuments, *above*, as sundials.

Mythology and Sun Worship. Many ancient peoples worshiped the sun as a god. They included the Egyptians in Africa, the Sumerians in Asia, the Greeks in Europe, the Aztec and Maya Indians in North America, and the Inca Indians in South America. Some of these peoples thought an eclipse of the sun was the sun god's way of expressing his anger with them. They believed that prayers and sacrifices calmed his anger.

Many early beliefs about the sun were attempts to explain the sun's movement across the sky from east to west. The Greeks believed that the sun god Helios drove a chariot through the sky. The Egyptians believed that the sun god Re sailed a boat across the sky.

Other peoples who tried to explain the sun's motion included the Eskimos, and the Maoris of New Zealand. The Eskimos thought the sun took a boat trip at night beyond the northern horizon and was responsible for the *aurora borealis*, or northern lights (see AURORA BOREALIS). The Maoris believed that one of their heroes had fought the sun and crippled it, so that it limped across the sky.

Telling Time and Directions. Since ancient times, the sun has played an important part in man's efforts to keep track of time. The length of a day depends on the time the sun takes to return to a particular place in the sky as the earth rotates.

Ancient peoples used several kinds of devices to tell time. Sundials, for example, show the direction of the sun's shadow. The direction changes as the sun moves across the sky. Ancient calendars were based on the phases of the moon. The phases occur because sunlight reflected by the moon is seen from different angles as the moon circles the earth. Many ancient peoples built complicated structures to learn about the sun's motion from north to south and back again as the seasons changed. Such monuments as Stonehenge in England probably kept track of the motions of the moon and the sun (see STONEHENGE).

Today, the sun has an important role in navigating and surveying. Navigators and surveyors carefully measure the position of the sun to find their own position—and various other points—on the earth.

Art, Literature, and Music. Many artists, authors, and composers have put the beauty and warmth of the sun in their work. The Dutch painter Vincent Van Gogh created landscapes that expressed his joy with bright sunshine. The American poet Emily Dickinson wrote a poem called "The Sun," in which she described the rising and setting of the sun. The Russian composer Nicholas Rimsky-Korsakov included a beautiful song, "Hymn to the Sun," in his opera *The Golden Cockerel*.

Circular designs with extending spokes probably represent the sun and its rays. Varieties of this design include the cross, a symbol that appeared even before the time of Jesus Christ; and the *swastika*, a form of a cross (see SWASTIKA).

One Star Among Billions. More than 100 billion stars make up the Milky Way, which is only one of billions of galaxies in the universe. The stars in the Milky Way fan out from the center in wide, curving arms. The arms would give the galaxy a *spiral* (coil) shape if it could be seen from above. The sun is located about in the middle of one of the arms.

Astronomers estimate that the Milky Way was formed between 10 billion and 15 billion years ago. The sun's age of about 4,600,000,000 years makes it one of the fairly young stars in the galaxy. Some stars are much younger than the sun. They were formed during the last few million years.

How the Sun Was Born. Throughout the Milky Way, and in space between the galaxies, are huge clouds of gases and dust. New stars are formed when portions of the gases and dust join together and begin to contract under the force of gravity. The contraction produces heat. As a mass of gases and dust shrinks, some of the heat increases the temperature at the center of the mass. Finally, the temperature at the center becomes so high that thermonuclear reactions begin to occur. These reactions produce energy and cause the mass of gases and dust to shine as a star.

Astronomers believe that the sun was formed from a rotating mass of gases and dust. They think the planets were formed from knots of gases and dust that collected at various distances from the center of the rotating mass. Scientists do not know many details of the birth of the solar system, but study and exploration of space, the moon, and the other planets are helping to increase man's knowledge. Many astronomers believe that planets may also have formed near other stars when those stars came into being.

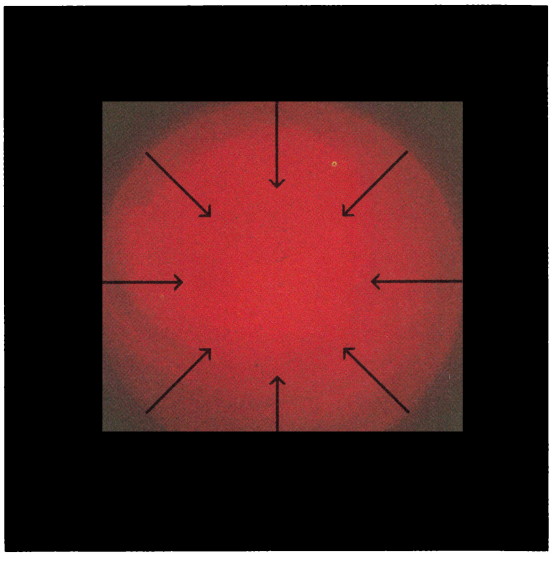
How Long Will the Sun Shine? The sun gets energy from thermonuclear reactions near its center. These reactions change hydrogen into helium. They release so much energy that the sun could shine for about 10 billion years with little change in its size or brightness. The sun is about 4,600,000,000 years old, and it probably will shine for at least another 5,000,000,000 years.

By studying other stars, astronomers can predict what the rest of the sun's life will probably be like. About 5,000,000,000 years from now, they believe, the center of the sun will shrink and become hotter. The surface temperature will fall slightly. The higher temperature of the center will increase the rate at which hydrogen changes into helium, and the amount of energy given off by the sun will also increase. The outer regions of the sun will expand about 30 to 40 million miles (48 to 64 million kilometers)—about the distance to Mercury, the planet nearest the sun. The sun will then be a red giant star. When the sun is a red giant, the earth's temperature will become too high for life to exist there.

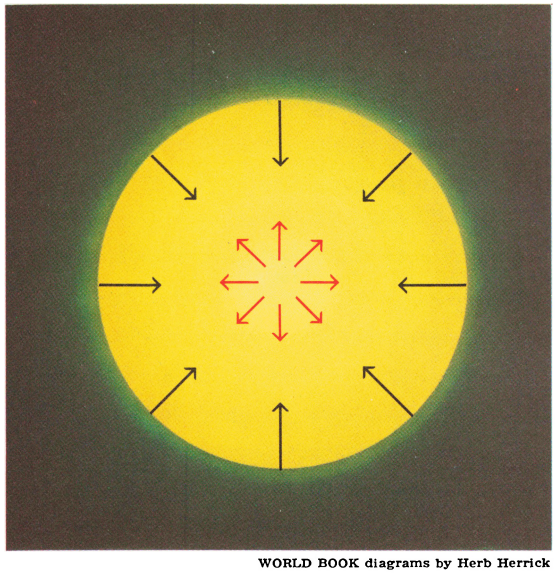
After the sun has used up its thermonuclear energy as a red giant, astronomers believe it will begin to shrink. After the sun shrinks to about the size of the earth, it will become a *white dwarf*.

The sun may throw off huge amounts of gases in violent eruptions called *nova explosions* as it changes from a red giant to a white dwarf. A star that becomes a white dwarf has entered a final stage of its existence.

After billions of years as a white dwarf, the sun will have used up all its energy and lost all its heat. Such stars are called *black dwarfs*. After the sun has become a black dwarf, the planets will be dark and cold. If the earth still has an atmosphere, the gases of the atmosphere will have frozen onto the earth's surface.



The Sun Was Born About 4,600,000,000 Years Ago. It formed when gravity, *black arrows*, pulled gases and dust in space together. As this mass contracted, the sun's center became so hot that nuclear reactions began, producing the sun's energy.



WORLD BOOK diagrams by Herb Herrick

The Sun Today is a yellow dwarf star. It keeps its size because the intense heat deep within the sun produces pressure, *red arrows*, that balances the force of the sun's gravity. This balance keeps the gases in the sun from pulling any closer together.

The Sun's Interior. The temperature at the *core* (center) of the sun is about 27,000,000° F. (15,000,000° C). There, the material of the sun is more than 100 times as dense as water, but it still consists of gases (see DENSITY). Thermonuclear reactions, which produce the sun's light and heat, occur in this inner third of the sun's interior.

Beyond the inner region is the *radiative zone*, which extends through about the middle third of the sun's interior. In this zone, the temperature is about 4,500,000° F. (2,500,000° C), and the gases are about as dense as water. Heat normally flows from a hot place to a cooler place, so the drop in temperature causes the energy produced in the center of the sun to flow toward the surface.

The *convection zone* begins about two-thirds of the way from the center of the sun and ends about 137 miles (220 kilometers) below the sun's surface. The temperature in this zone is about 2,000,000° F. (1,100,000° C), and the gases are about a tenth as dense as water. In the convection zone, the gases undergo violent churning motions called *convections* and *turbulence*. These motions help carry the sun's energy to the surface.

The Sun's Surface, or *photosphere*, is about 200 miles (320 kilometers) thick, and its temperature is about 10,000° F. (5500° C). The photosphere is actually the innermost layer of the sun's atmosphere. It is from 1 million to 10 million times less dense than water.

The photosphere consists of many small patches of gas called *granules*. A typical granule lasts only 5 to 10 minutes, and then it fades away. As old granules fade away, the sun's surface becomes marked with new ones. Scientists believe the granules are caused by waves in the photosphere. The waves are produced by the violent churning motion of the gases in the convection zone.

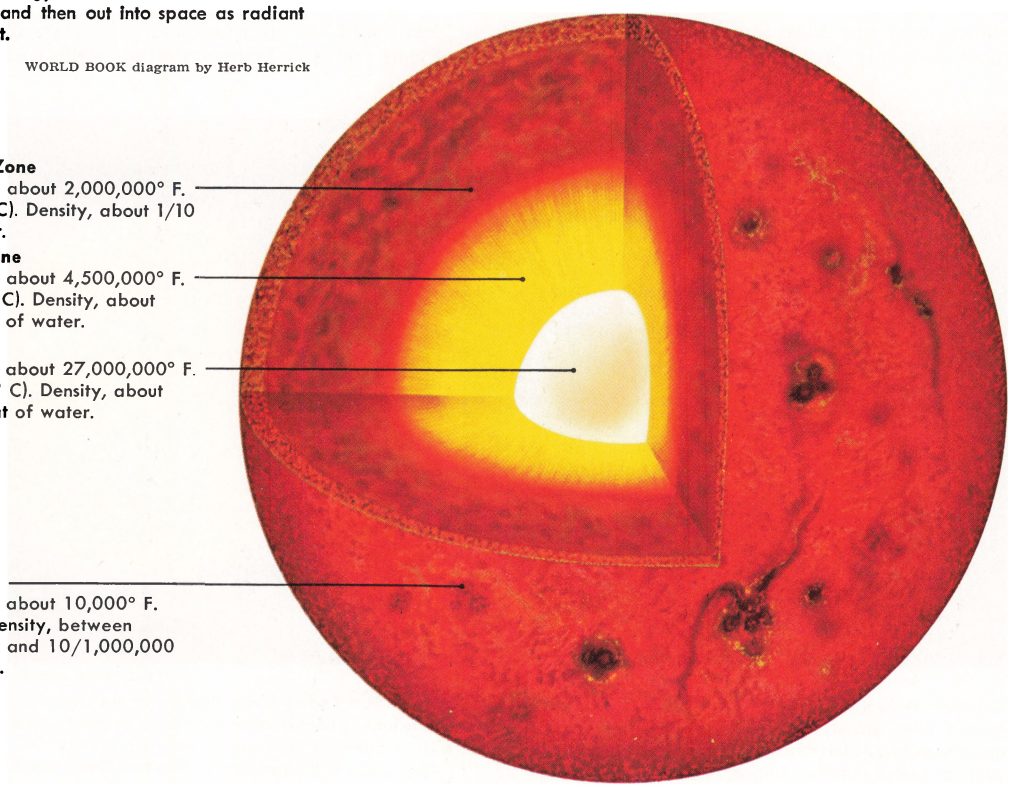
Astronomers also study other features of the photosphere to learn more about the sun. These features include dark spots on the photosphere called *sunspots*. Sunspots and other features are discussed in detail in the section of this article called *The Sun's Stormy Activity*. In addition, the photosphere is important because it gives off the sun's energy in the form of heat and light. Scientists learn much about the sun when they study the light given off by different parts of the photosphere.

The sunlight given off by the sun's surface is made up of many colors. These colors are not all equally bright. Various elements in the photosphere absorb some of the colors and prevent the sun from giving off

INSIDE THE SUN

Beneath the sun's *photosphere* (surface) are the violently churning convection zone, the radiative zone, and the core, where the sun's energy is produced. This energy flows from the core to the photosphere and then out into space as radiant heat and light.

WORLD BOOK diagram by Herb Herrick



those colors. Scientists can see what colors are absorbed by passing sunlight through a glass prism to form a spectrum. Where light has been absorbed, dark lines appear on the spectrum. These lines are called *Fraunhofer lines*, after Joseph von Fraunhofer, a German physicist who studied them during the early 1800's. Each element has its own characteristic pattern of Fraunhofer lines. Astronomers learned what elements are on the sun by comparing the Fraunhofer lines of the sun's spectrum with the lines that various elements show in laboratory experiments.

In photographs of the sun, the region near the edge of the disk does not appear so bright as the central region. This effect is called *limb darkening*. It occurs because light from the central region follows a more direct path to the earth than does light from the edge of the disk. As a result, less of the central light is absorbed by the sun's gases, and more light from deep within the photosphere can be seen. The deeper gases are hotter than those near the surface, and the hotter gases give off brighter light.

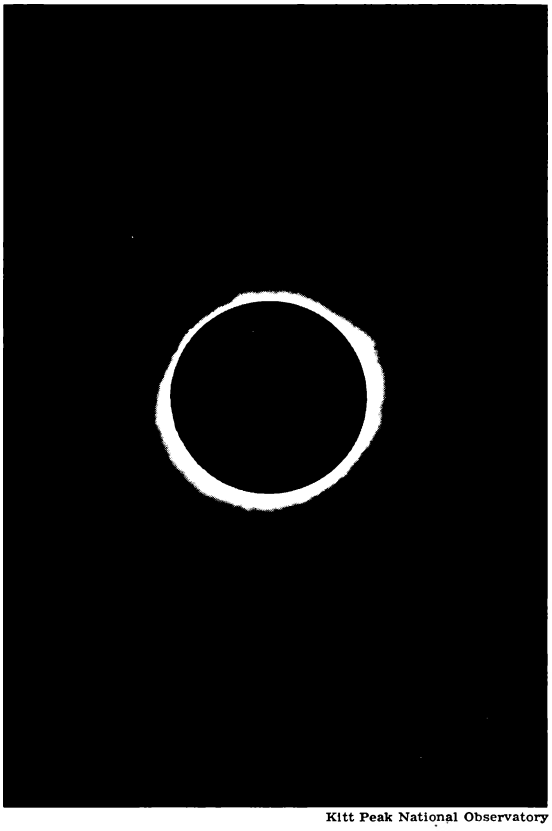
Above the Surface. About 100 miles (160 kilometers) above the photosphere, the temperature is about 8000° F. (4400° C). Beyond this point, the temperature rises again. In the *chromosphere* (the middle region of the sun's atmosphere), the temperature may be about 50,000° F. (27,800° C).

The chromosphere consists partly of streams of gas that shoot up briefly. These gas streams, called *spicules*, are about 500 miles (800 kilometers) thick and shoot as high as 10,000 miles (16,000 kilometers). A spicule lasts up to 15 minutes.

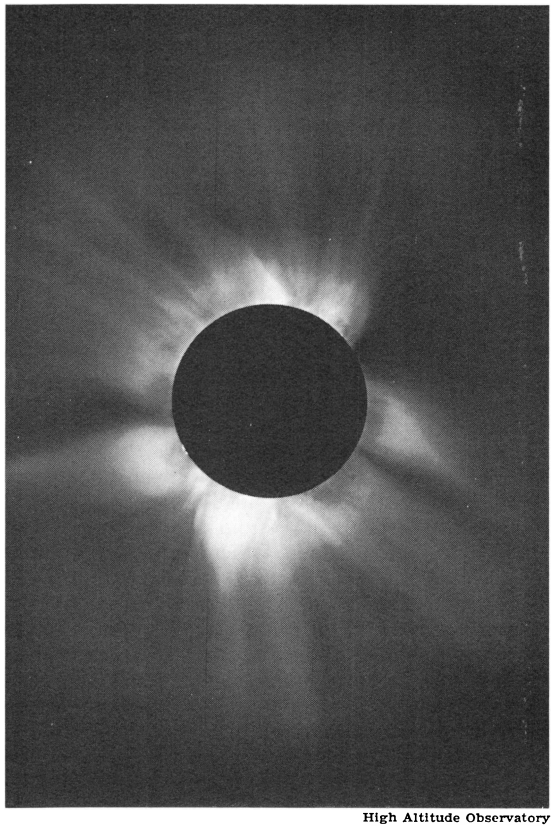
Above the chromosphere is a region called the *corona*, which has a temperature of from 2,000,000° to 3,000,000° F. (1,100,000° to 1,670,000° C). The molecules of the corona are so far apart that the gases of the corona have little heat. If an astronaut were in the corona and were shielded from the direct rays of the sun, he would have to heat his space suit.

The temperature drops slowly from the corona outward into space. The corona has no well-defined boundary. Its gases expand constantly away from the sun. This expansion of its gases is called *solar wind*.

The temperatures of the chromosphere and the corona are a puzzle to astronomers. Heat flows from hot areas to cooler areas, and yet the photosphere is cooler than the two outer regions of the sun's atmosphere. Astronomers believe that the high temperatures of the chromosphere and the corona result from the turbulence of gases in the convection zone.



Kitt Peak National Observatory



High Altitude Observatory

The Sun's Corona, the outermost region of its atmosphere, can be studied well during a solar eclipse. The sun showed little activity during an eclipse in November, 1966, *left*. It displayed prominences and other solar activities during the eclipse of March, 1970, *right*.

SUN/How the Sun Produces Energy

The sun *radiates* (gives off) energy into space in the form of light and heat. Every second, about 4 million short tons (3.6 million metric tons) of the sun's mass change into energy. The earth gets only about 4 pounds (1.8 kilograms) or about one two-billionth, of the total energy radiated by the sun every second. But this amount is enough to make life possible on the earth.

What makes the sun shine? How can the sun continue to shine if it gives off so much energy every second? People have asked these questions for thousands of years. But only about 1900 did man begin to learn the answers.

Solar Energy Theories. Before men knew the age of the earth and the sun, they tried to explain how the sun produces light and heat. Some believed that the sun was a giant ball of burning coal. Others thought that meteors falling into the sun released the sun's energy. During the 1800's, two physicists, Hermann von Helmholtz of Germany and Lord Kelvin of Great Britain, supported the theory that the sun's energy came from the slow shrinking of the sun. All these theories proved wrong.

Scientists believe that the sun is about 4,600,000,000 years old. Only one source of energy—nuclear energy—could have kept it shining that long. In the early 1900's, a number of scientists formulated theories about nuclear energy.

Sir Arthur Eddington, a British astronomer, showed that the center of the sun has a temperature of many millions of degrees. At this temperature, the nuclei of atoms join together in the process of *thermonuclear fusion*. Two physicists, Hans Bethe of the United States and Carl F. von Weizsäcker of Germany, described this process in the 1930's. These two scientists showed that thermonuclear fusion releases a sufficient amount of the sun's energy to keep the sun shining for billions of years.

The Thermonuclear Furnace. The changing of hydrogen into helium in the sun results in the release of the sun's energy in the form of heat and light. Helium is produced during a set of nuclear reactions. Scientists sometimes speak of these thermonuclear reactions as the "burning" of hydrogen. But such reactions are not "burning" as we think of the chemical process involving, for example, paper or wood.

The most important set of nuclear reactions in the sun is the *proton-proton chain*. These reactions involve protons and neutrons, the two major kinds of particles in the nucleus of an atom. The simplest of these proton-proton reactions has three steps. In the first step, two protons from two hydrogen nuclei fuse together. One of the protons immediately becomes a neutron by a process called *beta decay*. Now the proton and neutron make up the nucleus of a form of hydrogen called *deuterium*. In the second step, the deuterium nucleus captures another proton and becomes a light form of helium. In the third step, two light helium nuclei fuse, forming an ordinary helium nucleus. When they fuse, they give off two protons. The resulting helium nucleus has two protons and two neutrons. But it contains slightly less matter than the six hydrogen nuclei that took part in the process which formed the helium nucleus. Some of the matter that made up these hydrogen nuclei has become the energy that the sun radiates.

Another set of nuclear reactions produces less energy in the sun than do the proton-proton chains. These reactions form the *carbon-nitrogen-oxygen cycle*. In this cycle, protons are added successively to the nuclei of carbon, nitrogen, and oxygen. Carbon becomes nitrogen, and nitrogen sometimes becomes oxygen but more often becomes carbon. Some of the nuclei that have been formed undergo the process of beta decay. After four protons have been added, a helium nucleus is given off.

Hydrogen, the most plentiful element in the universe, makes up about three-fourths of the sun's mass. There is enough hydrogen to keep the sun shining for billions of years.

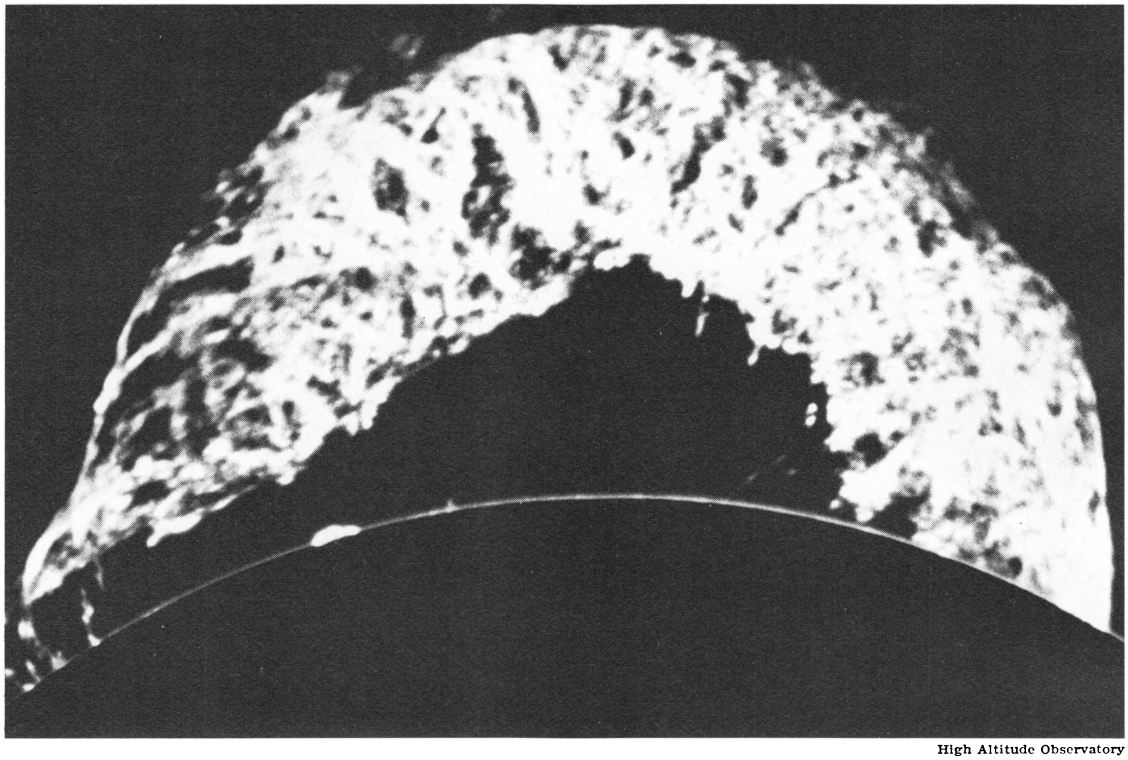
SUN/The Sun's Stormy Activity

A variety of spectacular activities takes place on the surface of the sun. When these activities become somewhat violent, they are called *solar storms*. Some solar storms occur in the form of huge arches of gas called *prominences*. The arches rise from the edge of the disk and flow back into the sun. Other solar storms occur in the form of areas of gas called *sunspots*. They appear and disappear in regular cycles. Still other solar storms take place as bright bursts of light called *flares*. Flares release huge amounts of solar energy.

Solar Magnetism. Astronomers have found that prominences, sunspots, flares, and other stormy activities on the sun occur because of changes in the patterns of *magnetic fields* on the sun. A magnetic field occupies the space around a magnet where magnetism exerts a force. Magnetic fields contain *magnetic lines of force*, or *flux lines*. In a bar magnet, the lines of force form a simple pattern (see MAGNET AND MAGNETISM [picture: Magnets of Different Shapes]).

The sun has a magnetic field that somewhat resembles the pattern of a bar magnet, especially near the sun's poles. But near the sun's equator, the magnetic pattern is always changing because the movement of gases there makes the magnetic field irregular. Atoms of those gases are *ionized*. An ion is an atom or group of atoms that has either gained or lost electrons. Many atoms of gas on the surface of the sun have lost electrons and form a type of gas called a *plasma* (see PLASMA). Particles trapped in a magnetic field usually follow the direction of the magnetic lines of force. But the motion of large quantities of plasma tends to change the direction of these lines. As a result, changes occur in the pattern of the sun's magnetic field, and stormy activity takes place.

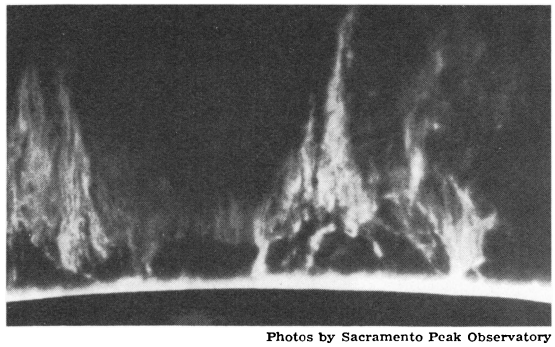
Prominences are one of the most interesting features of the sun. Each of these bright arches of gas outlines a long, strong bundle of magnetic lines of force. Prominences shine brightly because their gases have a higher



High Altitude Observatory

The Largest Erupting Solar Prominence that astronomers have observed occurred on June 4, 1946. Shown in its early stages above, it became almost as large as the sun itself in about one hour. Within a few hours, the huge prominence had disappeared completely.

Active Solar Prominences have short lives. The loop type of active prominence, *above*, may change rapidly in appearance during a period of only several hours.



Photos by Sacramento Peak Observatory

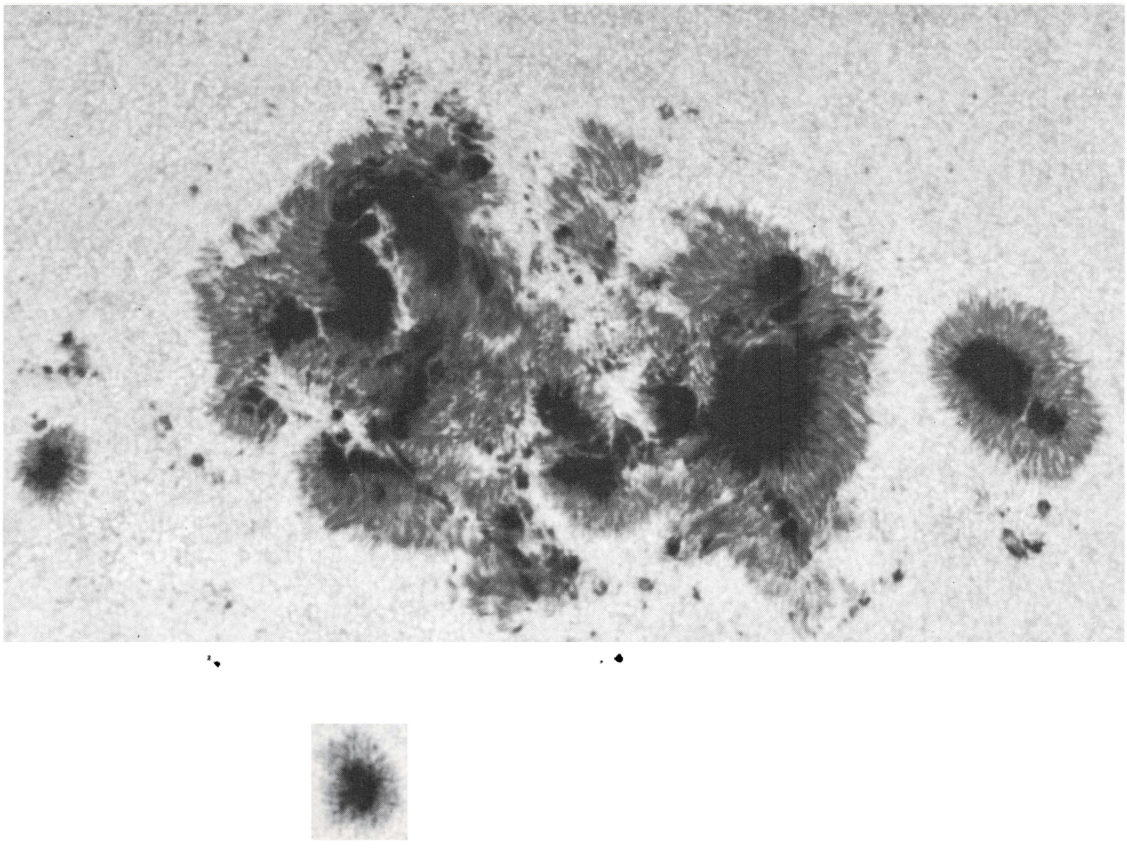
Quiescent Solar Prominences may take the form of a hedgerow, *above*, a curtain, or a funnel. A quiescent prominence changes little in appearance during its two- or three-month life.

density and radiate light more efficiently than do the gases in the chromosphere and the corona.

A typical prominence may reach 20,000 miles (32,000 kilometers) above the sun's surface. Its total length may be 120,000 miles (190,000 kilometers), and the gases may be 3,000 miles (4,800 kilometers) thick.

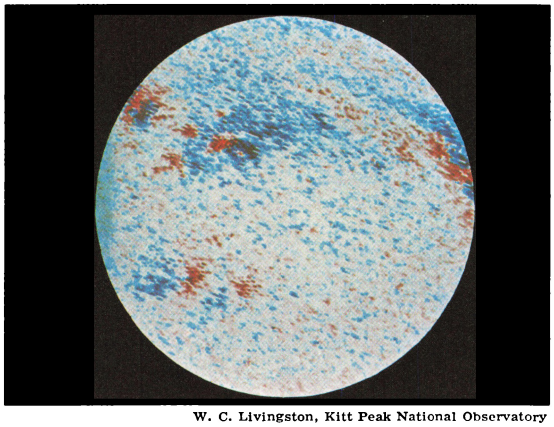
There are two kinds of prominences—*quiescent* and *active*. A quiescent prominence changes little in appearance during its two- or three-month existence. An active prominence changes rapidly during a period of only several hours. Some active prominences erupt and fling their gases rapidly into space.

Sunspots. Sometimes a strong loop of magnetic lines of force extends through the sun's surface. Where the lines cross through the surface, they lower the temperature of the gas. This gas does not shine so brightly as the surrounding gas, and it appears as a dark patch on the sun. These dark patches are called *sunspots*. Because a magnetic loop both leaves and re-enters the surface, two sunspots are associated with the loop. After a



Hale Observatories

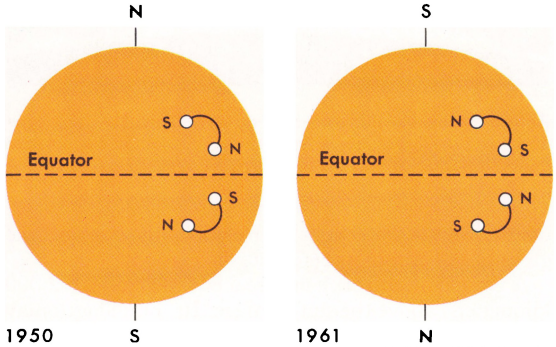
Sunspots Appear as Dark Patches on the sun's surface. They are caused by magnetic activity and appear and disappear in regular cycles. A sunspot may measure about 20,000 miles (32,000 kilometers) across. It may then break up into smaller sunspots and form a sunspot group, *above*.



W. C. Livingston, Kitt Peak National Observatory

A Magnetic Picture of the Sun shows active magnetic regions in the northern hemisphere as the sun approaches maximum sunspot activity. Areas of the magnetic picture shown in red indicate south magnetic fields. Areas shown in blue indicate north magnetic fields. The dark colors indicate strong fields.

A SUNSPOT CYCLE



WORLD BOOK diagram

During a sunspot cycle, which lasts 11 years, the number of sunspots first increases and then decreases to a minimum. When the next cycle begins, the magnetic fields of the sun and of the sunspots become reversed. So the sun takes two sunspot cycles—or 22 years—to go through a complete set of magnetic changes.

few days, a magnetic loop may break up into several thinner loops. Each of these loops crosses the surface at a different place. The original sunspot breaks up into several sunspots that form a *sunspot group*. Still later, the magnetic loops spread out and cover a wider area, and their sunspots fade away.

A typical sunspot may have a diameter of about 20,000 miles (32,000 kilometers). Most sunspots have two parts. The inner part, called the *umbra*, may have a diameter of about 8,000 miles (13,000 kilometers)—approximately the size of the earth's diameter. The outer part, called the *penumbra*, may have a diameter of about 12,000 miles (19,300 kilometers). The penumbra is lighter in color than the umbra. Some sunspots have no penumbra because of their small size.

The temperature of the gas in the upper photosphere and in the chromosphere above a sunspot group often rises about 1500° F. (815° C) above its normal temperature. As a result, it radiates more light than do surrounding gases. This light appears in patches called *faculae*, *flocculi*, or *plages*. They are more easily seen near the edge of the disk than near the center of the sun.

The number of visible sunspots varies from about 5 to approximately 100. It takes about 11 years for the number to increase from the minimum to the maximum. This 11-year period is called the *sunspot cycle*.

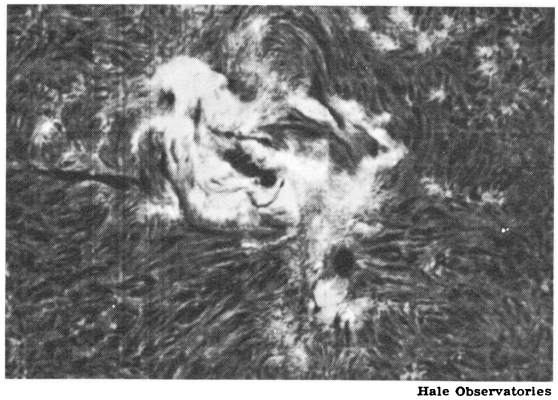
A sunspot cycle begins when sunspots appear at high solar latitudes. As the cycle continues, more sunspots appear closer to the sun's equator. During a cycle, the north and south magnetic poles of each pair of sunspots are reversed from those of the previous cycle. The north and south magnetic poles of the sun's general magnetic field also become reversed. Thus, the sun takes two sunspot cycles, or 22 years, to go through a complete set of magnetic changes.

Astronomers do not know why sunspot cycles take place. But they know that the cycles are closely connected with other kinds of solar activity. All types of these activities become most intense during the maximum phase of a sunspot cycle. See SUNSPOT.

Flares. After a sunspot group has existed for a long time, the magnetic lines of force usually become jumbled. As a result of the jumbling, magnetic energy is stored in the corona. The energy may be released in a spectacular discharge called a *flare*. In a flare, the magnetic lines of force become reconnected into a simpler pattern. The energy is released in the form of light, heat, and fast-moving atomic nuclei and electrons called *solar cosmic rays*.

A flare may be as small as a sunspot or as large as a sunspot group. The temperature in a flare is about twice as high as the temperature at the sun's surface. Flares radiate much light into space, and astronomers can photograph them against the background light of the sun. Small flares may last about 10 minutes. The largest ones last about an hour.

Large flares produce so many solar cosmic rays that important consequences occur on the earth. For example, the rays disrupt radio communications. They endanger astronauts in space, where the earth's magnetic field is not present to protect the men from such large amounts of radiation. After astronomers learn to predict the occurrence of large flares, they will be able to make space travel safer.



Hale Observatories

Flares Are Spectacular Discharges that release huge amounts of the sun's energy. A flare may be as large as a sunspot group, with a temperature twice that of the sun's surface.

Solar Radiation. The sun gives off many kinds of radiation besides visible light and heat. These radiations include *radio waves*, *ultraviolet rays*, and *X rays*.

Some radio waves of the sun are shorter than the radio waves used in broadcasting. Because they are shorter, they can penetrate the earth's atmosphere. As a result, astronomers can study them to learn about solar storms. Strong bursts of radio waves occur during violent solar activity. Astronomers think these bursts originate in sunspot regions, particularly when flares occur. The bursts last from a few minutes to a few days.

Ultraviolet rays consist of waves of light that are shorter than the waves of violet light on the visible spectrum. They are invisible to the human eye. Ultraviolet rays cause sunburn, and too much exposure to them may cause skin cancer. The atmosphere absorbs much of this radiation. The sun gives off more ultraviolet rays and X rays during periods of violent activity than during calm periods. Flares greatly increase the amount of radiation from the sun.

X rays are another form of solar radiation. The sun's X rays can injure or destroy the tissues of living creatures. The earth's atmosphere shields man from most of this radiation. See X RAYS.

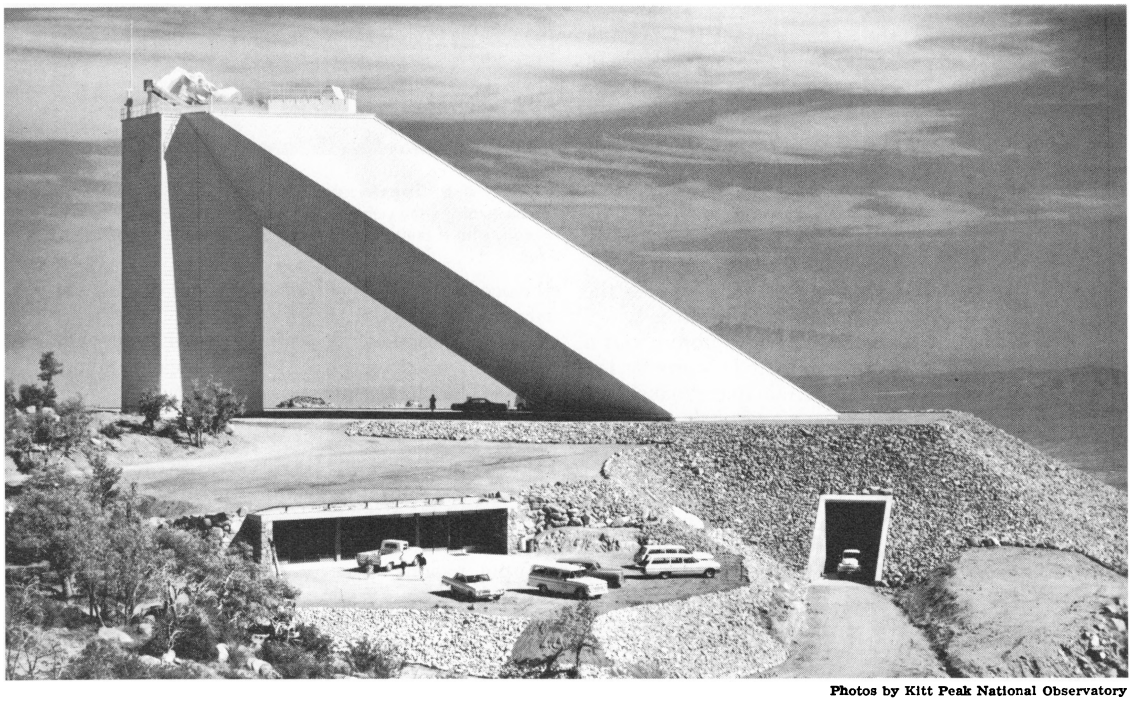
The Solar Wind. The corona is so hot that its gases continually expand away from the sun. This flow of gases continues into space until the gases mix with those near the outer planets of the solar system. The flow of gases is called the *solar wind*. When the solar wind reaches the earth's orbit, it is traveling at 1 million to 2 million miles (1.6 million to 3.2 million kilometers) per hour. The solar wind confines the earth's magnetic field into a specific volume of space called the *magnetosphere*. The boundary of the magnetosphere is about 40,000 miles (64,000 kilometers) from the earth.

Flares increase the speed of the solar wind. The solar wind then presses harder on the magnetosphere and causes magnetic storms on the earth. These storms interfere with radio communications and can make compass needles swing wildly. See SOLAR WIND.

Early Sun Science. Early man believed that the earth was flat and that the sun was a god. During the 400's B.C., the Greek philosopher Anaxagoras realized that the sun must be a large body, far from the earth. He estimated the sun's diameter at 35 miles (56 kilometers). Anaxagoras' ideas disagreed with the religious beliefs of his time. His life was threatened, and he finally was exiled from Athens.

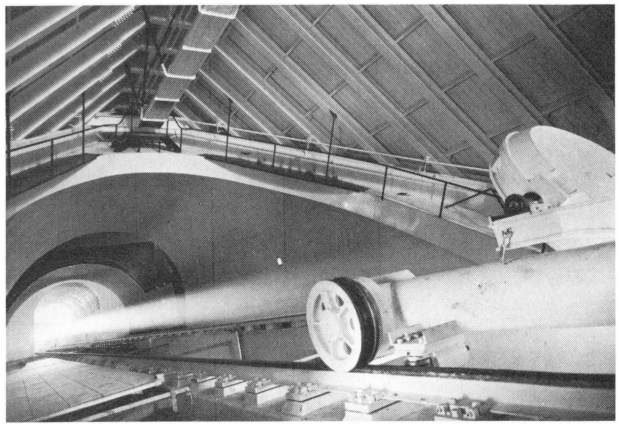
About A.D. 150, the astronomer Ptolemy of Alexandria declared that the earth was a stationary body in the center of the universe. He believed that the sun, moon, planets, and stars all circled the earth.

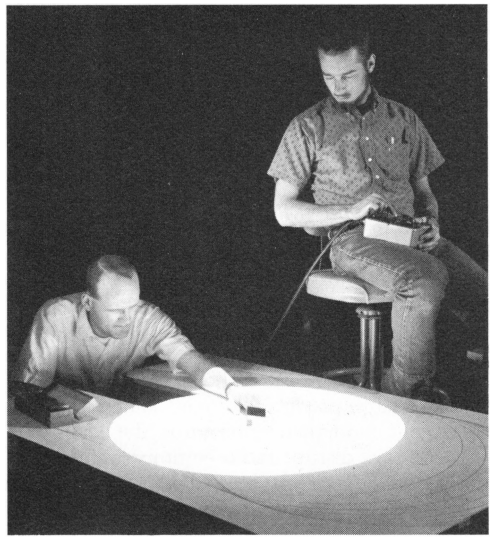
The true relationship between the earth and the sun became known in the early 1500's. In 1543, the Polish astronomer Nicolaus Copernicus stated that the sun was at the center of the solar system. He said that the



Photos by Kitt Peak National Observatory

The McMath Solar Telescope rises above the Kitt Peak National Observatory near Tucson, Ariz. The building, which is 100 feet (30 meters) high, houses the upper part of the telescope. About 180 feet (55 meters) of the telescope's 480-foot (146-meter) diagonal shaft is aboveground.





Sunlight streams 480 feet (146 meters) down the shaft of the McMath telescope, *above*, to a mirror 5 feet (1.5 meters) in diameter. The mirror reflects an image of the sun over 2½ feet (0.8 meter) in diameter to the underground viewing room, *right*.

earth and the other planets revolved around the sun.

Gradually, astronomers realized that the sun was a star and began to study it more scientifically. In 1904, the American astronomer George Ellery Hale established the Mount Wilson Observatory near Pasadena, Calif. This observatory included instruments for the study of the sun. Hale believed that by studying the sun, scientists could learn much about the other stars. He also made popular the word *astrophysics*, meaning the study of astronomical bodies by using the methods of physics.

Modern Solar Study. The earth receives far more light from the sun than it does from the other stars. To help astronomers study the light more effectively, *solar telescopes* spread it out as much as possible. For example, the solar telescope at the Kitt Peak National Observatory near Tucson, Ariz., produces an image of the sun that is about 32 inches (81 centimeters) in diameter. Even so, turbulence in the earth's atmosphere limits the detail that can be seen on the sun's surface. The smallest features that can be distinguished are about 500 miles (800 kilometers) across. Other solar telescopes include those at the Sacramento Peak Observatory near Alamogordo, N. Mex.; the High Altitude Observatory in Climax, Colo.; and the University of Michigan's McMath-Hulbert Observatory in Pontiac.

Astronomers use *solar spectroscopes* to analyze the sun's spectrum. These instruments spread out the colors of the spectrum to help in the study of sunlight.

One special instrument, the *coronagraph*, is used only for solar work. With it, astronomers can photograph the sun's corona without waiting for a total eclipse. The coronagraph is a tube with a disk in the middle to block out the light from the photosphere and chromosphere. With the coronagraph, astronomers can create an "eclipse" whenever they want to study the corona.

Space Age Discoveries. Only the visible light and the radio waves given off by the sun can be studied from the earth. Most solar radiation is best studied from space. During the 1960's, scientists first used rockets and then satellites in the Orbiting Solar Observatory program to learn about the sun's ultraviolet radiation. The best pictures of the sun's surface were taken from a high-flying balloon that was part of an experiment called *Project Stratoscope*. *Skylab*, a manned space laboratory launched in 1973, carried a solar telescope.

During the 1960's, astronomers used *space probes* (satellites sent into outer space) to study solar cosmic rays and the solar wind. The Pioneer spacecraft that were sent past the sun, and the Mariner flights to Mars and Venus, provided much information about these features of the sun. The astronauts of the Apollo 11 and Apollo 12 lunar flights conducted experiments to help scientists learn more about the solar wind.

In spite of all of man's efforts, he still has much to learn about the sun and its activities. Many more years of observation and study will be required for scientists to solve the mysteries of the sun. A. G. W. CAMERON

SUN / *Study Aids*

Related Articles in WORLD BOOK include:

Astronomy	Light	Solar System
Corona	Midnight Sun	Solar Wind
Earth	Milky Way	Solstice
Eclipse	Planet	Space Travel
Equinox	Radiation	Sun Worship
International Geophysical Year	Rainbow	Sundial
	Solar Energy	Sunspot

Outline

I. **Important Facts About the Sun**
   A. The Size of the Sun
   B. Distance to the Sun
   C. The Sun's Brightness
   D. The Sun's Heat
   E. The Sun's Mass
   F. What the Sun Is Made Of
   G. How the Sun Moves
II. **How the Sun Affects the Earth**
   A. Heat and Light for Life
   B. Weather
   C. The Sun As an Energy Source
III. **Man and the Sun**
   A. Mythology and Sun Worship
   B. Telling Time and Directions
   C. Art, Literature, and Music
IV. **The Sun As a Star**
   A. One Star Among Billions
   B. How the Sun Was Born
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V. **Regions of the Sun**
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   C. Sunspots
   D. Flares
   E. Solar Radiation
   F. The Solar Wind
VIII. **Studying the Sun**
   A. Early Sun Science
   B. Modern Solar Study
   C. Space Age Discoveries

Questions

Why does life on the earth depend on the sun?

What is a *red giant?* A *yellow dwarf?*

Why is sunlight white? Why does it sometimes appear to be colored?

What is the diameter of the sun? How does the sun compare in size with other stars? With the earth?

How does the coronagraph help astronomers study the sun?

In what ways does man use the sun as a source of energy?

What are *prominences*, *sunspots*, and *flares?* Why do they occur?

How old is the sun?

About how far is the earth from the sun?

What two elements make up the largest percentage of the sun's mass?

Reading and Study Guide

See *Sun* in the RESEARCH GUIDE/INDEX, Volume 22, for a *Reading and Study Guide.*

SUN BATH is the exposure of the body to sunlight or to sun lamps. Sunlight is made up of many different kinds of light rays. *Infrared rays* (heat rays) penetrate deeply into the body. They benefit the circulatory system and the muscles. *Ultraviolet rays* are chiefly absorbed by the skin, and may cause sunburn and tanning. They also cause chemicals in the skin to produce vitamin D, the sunshine vitamin. Sun lamps produce ultraviolet rays.

See also INFRARED RAYS; SUN (Heat and Light for Life; Solar Radiation); SUN LAMP; SUNBURN; ULTRAVIOLET RAYS.

SUN DANCE was the most important religious ceremony of many Plains Indian tribes. The Sioux called it the *sun gazing dance*, and performed it annually. They believed it would keep away enemies and famine.

All the scattered hunting bands of the tribe gathered in summer and pitched their tepees in a great camp circle. In the center of this circle they built a large, open enclosure of upright posts and rafters connected to a tall, forked center pole. Within the enclosure, Indian men taking part painted their bodies, fasted, and danced, always facing the sun. The ceremonies lasted several days. The dance itself was simple. The dancers merely rose on their toes to the tune of music played on eagle bone whistles. At the end of the dancing, some of the young men underwent severe tortures in fulfillment of vows. The United States government prohibited the sun dance for several years because of these cruelties. A few tribes, such as the Blackfoot, still perform the sun dance, but without the tortures. JOHN C. EWERS

See also BUFFALO CEREMONIALS.

SUN GOD. See SUN WORSHIP.

SUN HIGHWAY. See ITALY (picture: The Sun Highway).

SUN LAMP is a common name for a device that gives off artificial ultraviolet radiation. Ultraviolet rays are found in natural sunlight, and they produce a tan on human skin. These rays cannot be seen by the human eye. They have a shorter wave length than the visible violet light. There are two general types of ultraviolet generators, sun lamps and therapeutic lamps. A person can use a sun lamp in the home without the supervision of a physician. Therapeutic lamps require professional supervision, to avoid hazards of overexposure.

The professional therapeutic lamp gives off powerful ultraviolet radiation and can produce a sunburn in a period as short as one-half to one minute. The sun lamp is not as powerful. It requires 10 or 15 minutes to produce a light sunburn.

There are several sources of artificial ultraviolet radiation. The carbon arc is a readily available source. Its ultraviolet radiation is made more intense by impregnating the cores of the carbons with certain salts of metals. The mercury arc inside a quartz tube is a common source. Another source looks like an ordinary large incandescent lamp. Inside the special glass bulb is a small mercury arc in a tiny quartz tube. Also inside the bulb is a tungsten filament. The lamp screws into any ordinary socket of 115-volt alternating current power supply. The light from this source resembles the light from an ordinary incandescent lamp, but it is enriched with ultraviolet radiation.

Direct exposure of the skin to ultraviolet rays from the sun or from artificial sources results in the formation of vitamin D. There is no evidence that ultraviolet radiation increases or improves the tone of the tissues of the body as a whole, stimulates metabolism, acts as a tonic, increases mental activity, or tends to prevent colds as many persons believe. HOWARD A. CARTER

See also GERMICIDAL LAMP; ULTRAVIOLET RAYS.

SUN VALLEY, Idaho (pop. 180), a famous resort, lies in the Sawtooth Mountains of south-central Idaho. For location, see IDAHO (political map). In 1936, Averell Harriman, chairman of the board of directors of the Union Pacific Railroad, picked the site for development as a winter-sports center because of its brilliant sunshine and frequent winter snowfalls. The hotels at Sun Valley are the Sun Valley Lodge and Challenger Inn. Eight electric chair lifts serve over 40 ski runs. Other sports include skating, sleighing, and bowling. WILLIAM S. GREEVER and JANET GROFF GREEVER

See also IDAHO (A Visitor's Guide).

Sun Valley News Bureau

The Ski Slopes of Sun Valley, in Idaho's Sawtooth Mountains, rank as one of the world's most popular winter sports centers.

SUN WORSHIP developed in some lands as people came to associate the sun with the growing season and with warmth. It developed among agricultural peoples, who needed sunshine for their crops, but not among hunters or seed-gatherers, who did not depend on sunlight for their food supply. Sun worship was important in the cultures of ancient Egypt, Babylonia, Persia, and northern India. The peoples of Scandinavia also worshiped the sun. Teutonic peoples named the first day of the week for the sun.

Sun worship was important to American Indians in the agricultural lands that are now the southeastern and southwestern United States. It also grew up among the Aztec, Inca, and Maya peoples who lived in Central and South America.

Kings and princes in some lands believed themselves to be brothers or children of the sun, and they came to be worshiped as gods. For hundreds of years, the Japanese worshiped their emperor as a descendant of the sun goddess, Amaterasu-O-Mi-Kami.

See also APOLLO; HELIOS; RE; SUN (Man and the Sun; picture).

SUN YAT-SEN, *soon yaht-sen* (1866-1925), a Chinese statesman and revolutionary leader, fought to establish a republic of China. He is generally called the *Father of the Revolution.* Sun was too idealistic to be an effective political leader. But his *Three People's Principles* (nationalism, democracy, and socialism) became the guiding principles of the Chinese republic, established in 1912.

Brown Bros.

Sun Yat-sen

Sun was born of humble parents in the Chung-shan district of Kwangtung Province. He was educated at mission schools in Hong Kong and Honolulu, and became a doctor. From 1895 to 1911, he toured the United States, Japan, and Europe to organize sympathy for republican principles and to seek financial aid for his revolutionary movement against the Manchu dynasty. He was aided by Chinese overseas communities and English, American, and Japanese sympathizers.

The Kuomintang Party, headed by Sun, became a political entity in 1911 after the Wuhan uprising to overthrow the Manchu regime. From 1911 to 1922, Sun tried to unite China and establish a stable government. His party adopted a constitution, and Sun became the temporary president of the Chinese republic in 1912. The political situation at the time was turbulent. To further insure the unity of China, Sun resigned as president in favor of Yüan Shih-k'ai after only six and one-half weeks in office.

His Later Efforts. In 1913, Sun disagreed with Yüan's policies and organized a revolt. He fled to Japan, and the Kuomintang members of parliament were thrown out of office. Once again, the revolutionists assembled to set up a separate government under the 1912 constitution. In 1921, Sun became president of this government in Canton. He was driven out of his capital in 1922, but returned in 1923.

Sun continued to work for the unification of China. After failing to get assistance from Western powers, he turned to Russia. With funds and help from Russia, he reorganized the Kuomintang party and army in 1923. He set up the Whampoa Military Academy, with Chiang Kai-shek as superintendent. Sun died of cancer while attending a conference in Peking in 1925.

In 1929 Sun's body was transferred to a mausoleum erected in his honor in Nanking. Politically, he was more effective after his death. His principles became the slogans of his followers. Chiang Kai-shek, during the 1930's and 1940's, achieved the unification under a central government that Sun had sought in vain to accomplish. IMMANUEL C. Y. HSU

See also CHIANG KAI-SHEK; CHINA (History); SOONG CHING-LING.

SUNBIRD is the common name of a group of tiny tropical birds of Africa, Asia, and Australia. These birds resemble the hummingbirds of the Western Hemisphere in size and in the gay color of the male's feathers. They are larger than most hummingbirds. Their bills are curved instead of straight, like those of the hummingbird. Sunbirds feed on insects, spiders, and flower nectar.

Scientific Classification. Sunbirds belong to the order *Passeriformes.* They are members of the sunbird family, *Nectariniidae.* ARTHUR A. ALLEN

See also BIRD (Building the Nest).

SUNBURN is an inflammation of the skin caused by exposure to the sun's rays. A sun tan may be healthful, but a sunburn can be serious. The victim may suffer severe pain and discomfort. He may feel ill and have a fever. Even on cloudy days, it is possible to get a severe sunburn. The sun rays filter through the clouds. Sun rays reflecting from a body of water, or from ice, snow, or sand, increase the amount of burning. Such a burn is usually first or second degree.

Sunburn can be prevented by gradual exposure to the sun. If extensive exposure to the sun is unavoidable, a robe or covering of some kind should be worn part of the time. Olive oil or sun-tan lotion or ointment on the skin also helps as a preventive. A pill developed in the late 1950's makes it possible for a person to build up a resistance to sunburn. The pills are taken about two hours before exposure to the sun. They help promote a tan, and make the skin less sensitive to the sun.

Sunburn should be treated as you would treat any other kind of burn. If the skin blisters, apply a clean, dry gauze dressing over the burn. Make it tight enough so that it will not rub over the area. The dressing helps to protect the burn and keep it clean. Do not use lotions and oils on burns. Butter is particularly bad because the salt particles may irritate the burned area and cause more pain than the burn. BENJAMIN F. MILLER

See also SUN LAMP.

SUNDA ISLANDS. See INDONESIA (The Islands).

SUNDAY is the first day of the week among Christian peoples. It is the day set aside for rest and for worship of God. Sunday was the day sacred to the sun among the old Teutonic peoples, and its name means the "day of the sun." The French call Sunday *dimanche,* the Spanish call it *domingo,* and the Italians call it *domenica.* These three names all come from the Latin words *dies dominica,* which means Lord's Day.

The early Christians lived hard lives, and had to work on Sunday as well as the other days in the week. But they made Sunday a day for special worship, because they believed that the resurrection of Jesus occurred on that day. By the A.D. 300's, both the church and the state officially recognized the day as a day of rest in Europe.

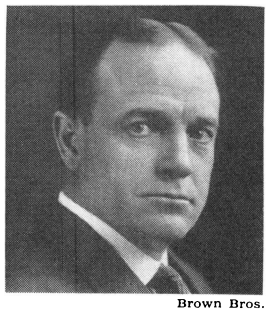
In the United States, some states have laws that forbid labor on Sunday. All government agencies and banks are closed on Sundays. A few states and communities have laws that prohibit such amusements as ball games and motion pictures on Sunday. Such laws are called *Blue Laws.* GRACE HUMPHREY

See also BLUE LAWS.

SUNDAY, BILLY (1862-1935), was a baseball player who became a famous evangelist. He used his baseball background, slangy language, flamboyant manners, and highly developed promotional methods to become the most popular evangelist of the time. He was supposed to have preached to over 100 million persons, and to have converted over a million in his campaigns.

SUNDAY ISLAND

William Ashley Sunday was born in Ames, Iowa. His early years were spent with his grandparents and at an orphans home. He played professional baseball for the Chicago White Stockings, Pittsburgh Pittsburgs, and the Philadelphia Phillies, from 1883 to 1891. During these years he was converted, and began working with the YMCA. He became a Presbyterian minister in 1903.



Brown Bros.

Billy Sunday

L. J. TRINTERUD

SUNDAY ISLAND. See KERMADEC ISLANDS.

SUNDAY SCHOOL, an observance usually connected with Protestant churches, teaches Bible study and religion. Such schools may have existed as early as the 1500's. But the present-day Sunday-school movement was started in Gloucester, England, by the publisher Robert Raikes. In 1780, he launched his "Ragged School." He tried to aid the children of the poor in his community by teaching them reading, writing, and the principles of religion. The schools received publicity through Raikes' newspaper. With the great "foreign" missionary work of the 1800's and 1900's, the schools spread to all parts of the world. When Raikes died in 1811, 400,000 children were enrolled in Sunday schools. Today, about 42,740,000 children and adults attend more than 437,000 Protestant Sunday schools. The Roman Catholic Church has a similar type of school.

WORLD BOOK photo, courtesy the United Methodist Church, Des Plaines, Ill.

A Sunday School teaches children the beliefs and background of a certain religion. Most of these schools are connected with Protestantism, but other faiths have similar programs. Classes are held at least once a week.

Sunday or Sabbath schools also are maintained by Jewish and other religious groups.

In America, the Sunday-school movement became widespread after the Revolutionary War. The American Sunday School Union was formed in 1824. Its missionary workers founded Sunday schools throughout the country. The International Sunday School Association served the United States and Canada. In 1922, this organization became the International Council of Religious Education. This organization became part of the National Council of the Churches of Christ in the United States of America in 1950.

The present-day Sunday school is divided into departments for students of various ages. In a large school, a superintendent directs each department and a teacher is in charge of each class. A uniform course of lessons is widely used in the United States and Canada. It is outlined by the International Council of Religious Education, which also prepares outlines for graded lessons used by many schools. Other features of current Sunday school work are circulation libraries, classes for teachers, conventions, and institutes that help train teachers.

See also RAIKES, ROBERT; RELIGIOUS EDUCATION.

SUNDEW is an unusual plant that traps and digests insects. It gets its name because drops of sticky fluid produced by glands appear on its leaves. In the sunlight, these drops glitter like drops of dew. Sundews live in bogs and marshes throughout the world. The *round-leaved sundew*, the most common kind, thrives in moist, acid soil in all but the southwestern United States. It also grows in parts of Canada, Europe, and Asia.

The slender stem of the sundew is topped by small white flowers. A cluster of flat, rounded leaves grows at the base of the stem, close to the ground. These leaves are the size of a small coin. They are covered with small red gland-bearing hairs. An insect may easily become stuck to the drops of sticky fluid on the leaves. Then the hairs fold in around the insect and hold it. Fluid covers the insect and suffocates it. The glands produce juices that digest the victim.

Scientific Classification. The sundews are in the sundew family, *Droseraceae*. They form the genus *Drosera*. The round-leaved sundew is genus *Drosera*, species *D. rotundifolia*.

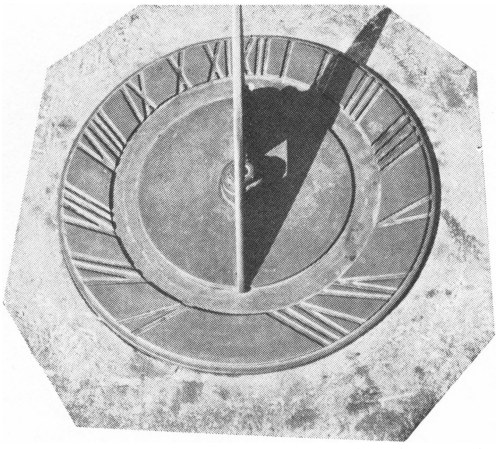
ROBERT W. HOSHAW

See also CARNIVOROUS PLANT; PLANT (picture: Plants That Eat Insects).

SUNDIAL is the oldest known device for the measurement of time. It is based on the fact that the shadow of an object will move from one side of the object to the other as the sun moves from east to west during the day. The sundial is believed to have been used in Babylon at least as early as 2000 B.C.

The earliest description of a sundial comes from Berossus, a Babylonian priest and author of the 200's B.C. His sundial was a hollow half-sphere, or dome, set with its edge flat and with a small bead fixed at the center. During the day the shadow of the bead moved in a circular arc, divided into 12 equal parts. These were called *temporary hours* because they changed with the seasons. *Equal hours* were decided upon about A.D. 1400, when clocks were invented.

A sundial consists of the *plane* (dial face) and the *gnomon* (style). The dial face is divided into hours and sometimes half and quarter hours. The gnomon is a flat piece of metal set in the center of the dial. It points



Robert W. Young, Black Star

A Sundial Tells Time by measuring the angle of a shadow cast by the sun. Many sundials have faces numbered in Roman numerals from 5 A.M. to 8 P.M. When the sun hits the *gnomon*, a flat piece of metal in the center of the dial, it casts a shadow which tells the time. The time on the sundial, *above*, is 2:45 P.M.

toward the North Pole in the Northern Hemisphere and toward the South Pole in the Southern Hemisphere. The upper edge of the gnomon must slant upward from the dial face at an angle equal to the latitude of the location of the sundial. ARTHUR B. SINKLER

See also SUN (Man and Sun [picture]).

SUNDIATA KEITA (? -1255) ruled the Mali Empire from about 1240 to 1255. He helped make it one of the largest and wealthiest empires in West Africa.

Sundiata became a hero of the empire—and is still a hero of the Malinke people of West Africa—because he freed the small state of Kangaba from Ghana. Sundiata reorganized the Kangaba army and, in the Battle of Kirina in 1235, defeated the forces of Sumanguru. Sumanguru was the last of the powerful rulers of what once was the Ghana Empire. As a result of Sundiata's victory, Kangaba became the core of Mali.

Sundiata built the city of Niani after 1235 and made it his capital. Niani and later capitals lay between salt mines and gold mines on the trans-Saharan trade routes. The Mali Empire became an important trade center after Sundiata gained control of the gold-producing areas. LEO SPITZER

See also MALI EMPIRE.

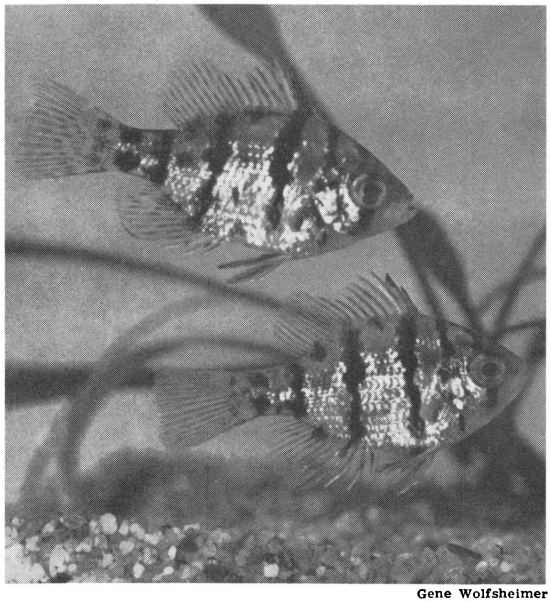
SUNDOG. See HALO.

SUNFISH is a name for several kinds of fish. In the fresh waters of North America, the sunfishes are a group of small, bright-colored food fish, rarely over 10 inches (25 centimeters) long. Their color changes according to conditions of health, food, and temperature. The males become brightly colored in the breeding seasons. They clear out a nest on the bottom of a lake or stream and guard the eggs against intruders. The most widely favored game fish among the sunfishes proper (except for the black basses, which belong to the same family) is the *bluegill*. The pumpkin seed, a kind of sunfish, is found abundantly in brooks and ponds from Maine to Florida, and in the northern part of the Mississippi Valley. It has a roundish body and considerable orange in its color. There is a bright red spot on the ear flap. This fish grows up to 8 inches (20 centimeters) long and weighs as much as 8 ounces (230 grams). People enjoy fishing for it, because it bites with so much vigor. These sunfish are usually caught with worms as a bait. Other species also are common. Some of the smaller, more brilliant kinds of sunfish are kept in home aquariums.

The name sunfish also is given to a group of grotesque-appearing ocean fish. Their bodies are scaleless, silvery, and clumsy, and seem to consist of one great head with small fins. They often rest on the surface in sunny weather, with one fin above the water. Ocean sunfish may weigh 1,000 pounds (450 kilograms). They are never eaten. They are not closely related to freshwater sunfish.

Scientific Classification. Ocean sunfish belong to the mola family, *Molidae*. The common kind is genus *Mola*, species *M. mola*. Fresh-water sunfish belong to the family *Centrarchidae*. The bluegill is genus *Lepomis*, species *L. macrochirus*. The pumpkin seed is *L. gibbosus*. CARL L. HUBBS

See also CRAPPIE; FISH (pictures).



Gene Wolfsheimer

The Black-Banded Sunfish ranges from New Jersey to Maryland. It grows about 4 inches (10 centimeters) long and has a pearly luster in reflected light. Sunfishes eat insects and shellfish. Most sunfishes lay their eggs in shallow water.

SUNFLOWER is a large flower. It has a great sunlike flower head with surrounding "rays" of yellow petals.

The annual garden sunflower is one of the best known of several kinds. When it is cultivated, its flower head may grow to be over 1 foot (30 centimeters) in diameter. The head is a flat disk with a row of large, yellow petals around its edge. The other petals are small, tubular flowers which form rows of circles in the center of the head. The plant has coarse, heart-shaped leaves and a rough, hairy stem that may reach a height of 15 feet (5 meters). Many small leaves surround the disk, and help to protect its delicate parts.

John M. Coffman, NAS

The Large, Beautiful Sunflower can be used for a number of purposes. Farmers in many parts of the world raise sunflowers, *left*. Sunflower seeds are crushed to obtain cooking oil and livestock and poultry feed. They are also sold as food for human beings and as bird seed. A sunflower head, *above*, may measure more than 17 inches (43 centimeters) across.

Jane Downton, Tom Stack & Associates

Some sunflowers come up every year, but growers must raise the garden variety from seed each year. The perennial species are excellent to plant against walls and fences. Farmers grow sunflowers for seeds. The seeds are used as feed for cattle and poultry and to make vegetable oil. Some people eat sunflower seeds. In parts of Europe, people use sunflower stalks as fuel.

Scientific Classification. Sunflowers belong to the composite family, *Compositae*. The common annual is genus *Helianthus*, species *H. annuus*. Among the perennials are *H. orgyalis* and *H. decapetalus*. MARCUS MAXON

SUNFLOWER STATE. See KANSAS.

SUNG DYNASTY, *soong*, ruled China from 960 to 1279. The Chinese made great urban and commercial expansion during this period. Their painting, ceramics, book printing, and philosophy reached a new high point in development. A general, Chao K'uang-yin, founded the dynasty and served as its first emperor. He succeeded in creating a strong, centralized dynasty. The Sungs controlled most of China, except the northeast, until 1127. Then the Jurchens from Manchuria seized North China. In 1279, the Mongols conquered southern China and ended the dynasty. H. F. SCHURMANN

SUNNI ALI, *SUN ee AHL ee* (? -1492?), ruled the Songhai Empire in West Africa from 1464 to 1492. He began to absorb the Mali Empire about 1464 and developed Songhai into the most powerful state in the western Sudan.

Sunni Ali conquered many neighboring countries. He captured Timbuktu in 1468 and threw out the Tuareg nomads who had held the city since 1433. About 1475, Sunni Ali conquered Jenne, another important center of trade.

Sunni Ali established law and order in the Songhai Empire and encouraged trade. He disappeared mysteriously in 1492, and historians believe he may have drowned in a flood. LEO SPITZER

See also SONGHAI EMPIRE.

SUNNITE. See ISLAM (Sects).

SUNNYVALE, Calif. (pop. 95,408), is a residential and industrial city 37 miles (60 kilometers) southeast of San Francisco. Its industries manufacture electrical equipment, processed foods, machinery, and chemicals. It is a center for both guided missile research and satellite tracking operations. The city was incorporated in 1912. It has a council-manager government. For location, see CALIFORNIA (political map). GEORGE SHAFTEL

SUNSET BOULEVARD. See LOS ANGELES (Central Los Angeles).

SUNSET CRATER NATIONAL MONUMENT is near Flagstaff, Arizona, and was established in 1930. The volcanic cinder cone for which the monument was named ranks as its chief feature. The monument has a large crater with a brilliantly colored summit and extensive lava flows. It also contains an ice cave that is cold the year around. Ponderosa pine trees grow in the 3,040.00-acre (1,230.24-hectare) area. For location, see ARIZONA (physical map). C. LANGDON WHITE

SUNSHINE SKYWAY is one of the longest overwater crossings in the United States. It stretches 15 miles (24 kilometers) across Tampa Bay in Florida, linking St. Petersburg and Bradenton. It consists of two parallel

roadways built over causeways connected by bridges. The first roadway was completed in 1954 and the second in 1971.

SUNSHINE STATE. See FLORIDA; SOUTH DAKOTA.

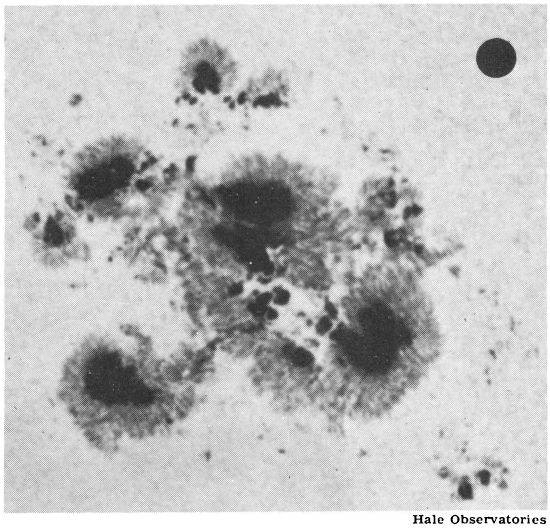
SUNSPOT is an area on the surface of the sun that appears dark in contrast to the gases surrounding it. Sunspots occur when the gases in a region of the sun become temporarily cooler than the surrounding gases. Astronomers do not know exactly how or why sunspots form nor how they are related to other events on the sun. Sunspot activity is associated with *solar flares*, violent eruptions on the surface of the sun. But the reasons for the connection remain uncertain.

Sunspots vary greatly in size and duration. A small sunspot may measure 1,000 miles (1,600 kilometers) wide and last from an hour to several days. A large sunspot may be nearly 100,000 miles (160,000 kilometers) wide and last for months.

Most sunspots have a dark central region called the *umbra* that is surrounded by a less dark region, the *penumbra*. Some small sunspots, called *pores*, have an umbra but no penumbra. The umbra is from 3 to 10 times less bright than the sun's surface and may be as much as 3600° F. (2000° C) cooler. The penumbra is about two-thirds as bright as the sun's surface.

Most sunspots occur in pairs or groups, of which one spot is generally the largest. This spot seems to "lead" the others in the direction of the sun's rotation. Nearly all sunspots are found near the sun's equator. The spots are small at first but grow larger. At the beginning of a sunspot cycle, a few spots appear about 30° north and south of the sun's equator. Later, more spots appear, closer to the equator, and reach a maximum number at about 15° north and south latitude. The number of spots then decreases, until the last spots fade away at about 8° north and south latitude. The total number of spots reaches a maximum and then declines to a minimum during a fairly regular cycle of 11 years.

Sunspots have strong magnetic fields that astronomers believe may have much to do with the formation of the spots. The magnetism often remains in the region of a sunspot even after the spot has disappeared.



Hale Observatories

Sunspots may cover an area of the sun many times greater than the size of the earth. The black circle, *upper right*, shows the approximate size of the earth compared with that of sunspots.

Because of the magnetic field, a sunspot acts like an end of a magnet. During one 11-year cycle, the leading spots of pairs or groups above the sun's equator seek the same magnetic direction. The leading spots of pairs or groups below the equator seek the opposite magnetic direction. Thus, if the leading spots above the sun's equator behave like the south-seeking end of a magnet, the leading spots below the equator behave like the north-seeking end. However, at the beginning of the next 11-year cycle, this behavior is reversed. That is, the north-seeking spots become south-seeking, and the south-seeking spots become north-seeking. Astronomers cannot explain this phenomenon. But because of it, a full sunspot cycle actually lasts 22 years. ERIC D. CARLSON

See also AURORA BOREALIS; MAGNETIC STORM; SUN.

SUNSTROKE is the common name for conditions that result from overheating the body. Doctors usually use the more specific terms *heatstroke* and *heat exhaustion*. Sunstroke is a form of heatstroke caused by being exposed to the sun too much or too long.

Heatstroke usually results when the heat-regulating mechanisms of the body break down. The body maintains its normal temperature in several ways. Among them is the cooling effect that results when sweat evaporates. Researchers found that people who work in excessive heat for a long time sweat less and less. They may stop sweating altogether and their body temperature rises to dangerous levels. Doctors consider true heatstroke a medical emergency because the high body temperatures cause brain damage.

Persons with heatstroke rarely are aware that they have stopped sweating. But they suddenly notice a rapid rise in temperature. The body temperature of a patient may be 112° F. (44° C). His skin feels hot and dry. His breathing is regular, and his pulse full and pounding. Soon the breathing becomes irregular, the pulse weakens, and coma develops (see COMA).

Victims of heatstroke need immediate treatment. Those who are not treated may die. A doctor should be called at once. The most important thing is to reduce the temperature as quickly as possible. Doctors often place the patient in a bathtub filled with cold water. They apply cold compresses or ice packs to the head and neck. When the patient's temperature drops to about 102° F. (39° C), the drastic cooling measures usually are stopped. Most persons who have had heatstroke become ill quickly when exposed to heat again.

Heat Exhaustion, or *heat prostration*, is less severe than heatstroke. It generally occurs in persons who work near boilers, or in places with high temperatures and humidity. Victims become weak and dizzy and fall into a stupor. They usually perspire freely, and their temperature drops below normal. Their condition is like that of a person in shock (see SHOCK). These persons should be removed to a cooler location. But because of their subnormal temperature, they should be kept warm. Persons who work under conditions that might produce heat exhaustion drink large amounts of water and often take salt tablets to replace salt lost from their body when they sweat. LOUIS D. BOSHES

SUOMI. See FINLAND (table: Facts in Brief).

SUPERCHARGER is a device that adds power to a gasoline or diesel engine. It does this by compressing, or squeezing, the air fed into the cylinders. The extra air helps the fuel burn more completely, and makes the engine produce more power.

An understanding of how the supercharger works can be gained through an experiment with a drinking glass and a few sheets of paper. Crumple the paper into several large wads. One of the wads will almost completely fill the glass. Next, squeeze the paper wads until they are smaller. Now several wads will fit in the glass.

A cylinder in a gasoline engine is like the drinking glass. It can be filled with a "loose" amount of air like the one larger paper wad. But if the air is squeezed by a supercharger, just as the paper wads were squeezed, then the cylinder can hold several times as much air.

Superchargers are particularly useful on airplane engines. This is because the air pressure decreases as an airplane goes higher. In other words, the air becomes more loosely packed, like the big paper wad. At high altitude the supercharger packs the air tightly to keep the gasoline burning well. Superchargers are sometimes used in boat and automobile engines.

Sometimes gears connected to the engine drive the supercharger. *Turbosuperchargers* are driven by a gas turbine turned by the engine exhaust.

An airplane pilot may shift gears on some superchargers so that the speed of the supercharger may be increased at higher altitudes. Other superchargers have automatic controls to make them go faster when the outside air pressure decreases. H. S. STILLWELL

See also DIESEL ENGINE; GASOLINE ENGINE.

SUPERCONDUCTIVITY is the ability of a material to conduct electricity without offering any resistance to it. Certain materials become superconductive when cooled to temperatures near *absolute zero* (−459.67° F. or −273.15° C). Good superconductors include lead, mercury, and tin.

Someday, superconductors may improve nearly every device that uses electricity. For example, superconductors could make smaller, more powerful electric motors and electromagnets. Superconductors could also carry electric power great distances without any loss of power due to the resistance of ordinary conductors. Some superconductors have been used in special motors and electromagnets for scientific research.

Materials that become superconductors at warmer temperatures must be developed before superconductivity can have widespread use. For most uses, the problem of keeping a material's temperature near absolute zero outweighs the benefits of superconductivity.

The Dutch physicist Heike Kamerlingh Onnes discovered superconductivity in 1911. Onnes found that the resistance of mercury suddenly dropped to zero when its temperature fell below −453° F. (−269° C). The temperature where the resistance of a material suddenly drops to zero is called the *critical temperature* of that material. Above that temperature, the material resists an electric current. A superconductor below its critical temperature also resists current if a large enough magnetic field is applied to it. PHILLIP W. ALLEY

See also CRYOTRON; CRYOGENICS.

SUPEREGO. See FREUD, SIGMUND; PSYCHOANALYSIS.

SUPERHETERODYNE. See ARMSTRONG, EDWIN H.; RADIO (Amplifiers).

SUPERHIGHWAY is any highway with four or more traffic lanes that has eliminated crossings with other highways and railroad tracks. Some superhighways stretch over 100 miles (160 kilometers) in length. Automobile traffic can often travel safely on them at speeds from 60 to 80 miles (97 to 130 kilometers) per hour. Direct intersections with other traffic are avoided by underpasses, overpasses, or curving intersections shaped like a clover leaf. Famous United States superhighways include the Pennsylvania, New Jersey, and Ohio turnpikes. See also FREEWAY; TURNPIKE.

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See also GOVERNMENT PRINTING OFFICE.

SUPERIOR, Wis. (pop. 32,237), is a port on Lake Superior, opposite Duluth, Minn. Superior and Duluth form a metropolitan area with 265,350 persons. Superior has one of the largest ore docks in the world. The docks store 550,000 short tons (499,000 metric tons) of iron ore. Superior's grain elevator holds 13 million bushels (354 million kilograms) of grain. It is one of the largest in the United States. One of the largest U.S. farmers' grain cooperatives does more than $3 million worth of business a year in Superior. Shipbuilding is an important industry. Superior also has large flour mills, railroad and machinery shops, woodworking factories, canneries, and breweries. The city is the home of the University of Wisconsin-Superior. Fur traders camped on the site of the city in 1662. In 1883, iron ore was discovered in the area. Superior is the seat of Douglas County. It has a council-manager government. JAMES I. CLARK

SUPERIOR, LAKE. See LAKE SUPERIOR.

SUPERLATIVE. See COMPARISON.

SUPERMAN. See NIETZSCHE, FRIEDRICH.

SUPERMARKET is a large retail store that provides a one-stop food-shopping service. It offers foods of all kinds in one location. Five principal characteristics of a modern supermarket are its large size, the wide variety of foods it offers, its self-service system for shoppers, sales on a cash-and-carry basis, and its many nonfood items. Nonfood items include housewares and kitchen aids, cosmetics and beauty aids, magazines, and, sometimes, hardware, cutlery, and lawn-care materials. Some supermarkets provide snack bars, playgrounds and entertainment facilities for children, and parking areas for cars.

Supermarkets, originally found chiefly in the United States, now are found in many parts of Europe and Latin America. EDWIN E. HARGRAVE

See also FOOD (picture: Foods Today).

SUPERNATURALISM. See METAPHYSICS (Doctrines); MYTHOLOGY (introduction).

SUPERNOVA. See NOVA.

SUPERREGENERATION. See ARMSTRONG, E. H.

SUPERSONIC FLIGHT. See AERODYNAMICS (Shock Waves and Sonic Booms); AIRPLANE (History).

SUPERSTITION is a traditional belief that a certain action or event can cause or foretell an apparently unrelated event. For example, some superstitious people believe that carrying a rabbit's foot will bring them good luck. Others believe that if a black cat crosses their path, they will have bad luck. To yet other superstitious people, dropping a knife or fork on the floor means company is coming. Such beliefs are superstitions because in each case the action and the event it foretells are traditionally thought to be connected.

Superstitions have existed in every human society throughout history. Most people, including highly educated individuals, act superstitiously from time to time. Many persons may joke about avoiding bad luck by knocking on wood or not walking under a ladder. But they have such beliefs anyway. Scholars once believed that all superstitions dated back to man's early history. But many superstitions have appeared in relatively recent times. According to one of the superstitions in baseball, for example, a pitcher will give up at least one hit if anyone mentions that he is pitching a no-hit game.

Countless human activities are involved in superstitions. These activities include eating, sleeping, working, playing, getting married, having a baby, becoming ill, and dying. Times of danger and uncertainty have brought many superstitions. Other superstitions concern animals, clothing, lakes, mountains, names, numbers, the planets and stars, the seasons, the weather, and various parts of the body.

Kinds of Superstitions. Many superstitions deal with important events in a person's life, such as birth, entering adulthood, marriage, pregnancy, and death. Such superstitions supposedly ensure that a person will pass safely from one stage of life to the next. For example, a person born on Sunday will always have good luck. A bride and groom will have bad luck if they see each other on their wedding day before the ceremony. A pregnant woman must eat the right food, or she will give her child an unwanted birthmark. After a person dies, the doors and windows of the room should be opened so his spirit can leave.

Some superstitions involve a type of magic. One form of such magic comes from the belief that similar actions produce similar results. Many people believe that a newborn baby must be carried upstairs before being carried downstairs. In this way, the child will be assured of rising in the world and having a successful life. According to a Japanese belief, a sick person should be given a potted plant instead of cut flowers. A live plant represents hope for the patient's recovery, but cut flowers are dead and soon wither. The same principle of magic appears in the custom of putting money in a purse or wallet being given as a gift. The giver wants to make sure that the purse or wallet will always contain money.

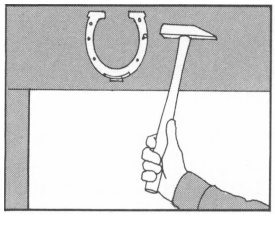
A number of superstitions involve someone's taking a deliberate action to cause something to happen or to prevent something from occurring. Most of these *causal* superstitions involve ensuring good luck, avoiding bad luck, or making something good happen. For example, carrying a silver dollar supposedly brings good luck. Some persons will not start a trip on a Friday, especially if that Friday falls on the 13th day of the month. Friday and the number 13 are both associated with bad luck. Wedding guests throw rice at the newlyweds to ensure that the marriage will result in many children. Causal superstitions may also involve actions intended to give bad luck to someone. Witches supposedly perform some of these actions (see WITCHCRAFT).

Other superstitions foretell an event without any

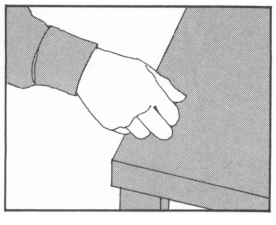
WELL-KNOWN SUPERSTITIONS **Some superstitions foretell good luck, and others warn of bad luck. Many people believe that hanging a horseshoe over their door or finding a four-leaf clover will bring them good luck. Many also think that spilling salt or walking under a ladder means they will have bad luck.**

Good Luck

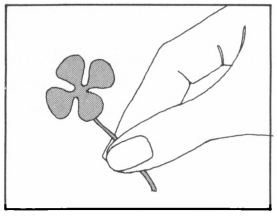
WORLD BOOK illustration by David Cunningham



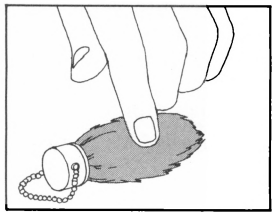
Hanging a horseshoe



Knocking on wood

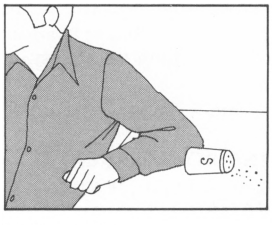


Finding a four-leaf clover

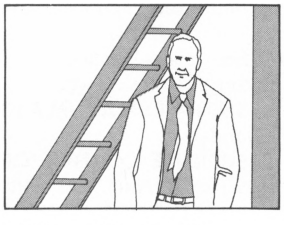


Rubbing a rabbit's foot

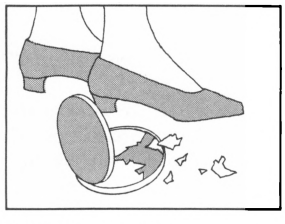
Bad Luck



Spilling salt



Walking under a ladder



Breaking a mirror

A black cat crossing your path

conscious action by the person involved. Some of these *sign* superstitions foretell good or bad luck. For example, finding a horseshoe or a four-leaf clover means good luck. Breaking a mirror or spilling salt brings bad luck. Other sign superstitions foretell a certain event or condition. A ring around the moon means rain will soon fall. A howling dog means death is near. A person with red hair has a quick temper.

Some sign superstitions may be changed into causal superstitions. If a person hangs a horseshoe over his door, witches cannot enter. If a young woman pins a four-leaf clover to her door, she will marry the first bachelor who comes in the door. In some cases, a person may avoid the bad luck involved in a sign superstition by taking immediate action. For example, someone who has spilled salt may cancel the bad luck by throwing a pinch of salt over his left shoulder.

The Role of Superstitions. Many people scoff at superstitions because they consider such beliefs unscientific. But many scholars believe that some superstitions have a scientific basis. For example, people in England once used tea made from foxglove plants to treat some forms of heart disease. Today, physicians often prescribe digitalis, a drug made from dried leaves of the purple foxglove, for patients with weak hearts.

Some superstitions have a practical origin. For example, many people believe that lighting cigarettes for three persons from one match will bring bad luck. This superstition may have originated among soldiers during World War I (1914-1918). At night, a match that stayed lit long enough to light three cigarettes provided a target for the enemy. Another superstition involves hanging a bag of garlic around a child's neck to protect him from illness. The bag has no supernatural power. But its smell keeps away other children—including any with a disease that the wearer of the bag might catch.

Most people have fears that make them insecure. Superstitions help overcome such fears by providing security. They reassure a person that he will get what he wants and avoid trouble. For example, millions of people believe in astrology and base important decisions on the position of the sun, moon, planets, and stars (see ASTROLOGY). Superstitions will probably have a part in man's life as long as people fear each other and have uncertainties about the future. ALAN DUNDES

Related Articles in WORLD BOOK include:

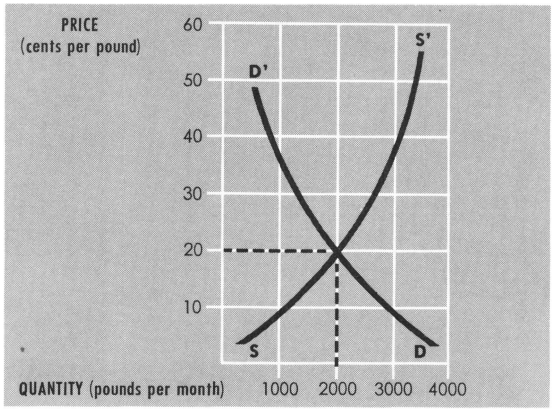
Amulet	Friday	Necromancy
Augur	Genii	Occult
Birthstone	Ghost	Omen
Divination	Magic	Palmistry
Evil Eye	Mental Illness	Voodoo
Exorcism	(History)	Weather (Weather
Fetish	Moon (Legend	Facts and Weather
Fortunetelling	and Folklore)	Superstitions)

SUPERSTRUCTURE. See BUILDING CONSTRUCTION (Parts of a Building).

SUPPÉ, *ZOO pay*, **FRANZ VON** (1819-1895), was an operetta composer. He produced large quantities of music in many forms during his lifetime. But of his great output, only a group of overtures has remained in active use. Such familiar overtures as *Poet and Peasant* (1846); *The Beautiful Galatea* (1865); *Light Cavalry* (1866); *The Jolly Robbers* (1867); *Fatinitza* (1876); *Boccaccio* (1879); and *Morning, Noon, and Night in Vienna* are performed regularly. Suppé was born in or near Spalato (now Split), Yugoslavia. HERBERT WEINSTOCK

SUPPLY AND DEMAND are economic forces that determine the amount of a product that is produced and its price. The *supply* of a product is the amount of it that businessmen are willing to produce and sell. Generally, the higher the price is, the greater the supply will be. Similarly, the *demand* for a product is the amount of it that users would like to buy. Demand also depends on the price, but in the opposite way. Usually, demand is lower at high prices than at low ones. Because the amount that producers actually sell must be the same as the amount that users actually buy, the only price at which everyone can be satisfied is the one for which supply equals demand. This is called the *equilibrium price.*

The supply and demand diagram with this article shows how these economic forces operate. Using the market for onions as an example, the *supply curve SS'* shows the number of pounds that farmers will produce each month at every possible market price. Higher prices encourage farmers to produce more onions, and low prices discourage production. Consumers' reactions are shown by the *demand curve DD'*, which shows how many pounds of onions customers want to buy each month at every possible price. At low prices, they want a great many onions. At high prices, they use other vegetables instead.



The supply and demand curves cross at a certain price (20¢ a pound in the example). When this is the market price, suppliers will offer just the quantity that users wish to buy. At any higher price, farmers will produce more onions than consumers are willing to buy, and competition among farmers will force the price down. At prices lower than equilibrium, purchasers will demand more onions than are available, and the scarcity of onions will drive the price up. ROBERT DORFMAN

See also ECONOMICS; FREE ENTERPRISE SYSTEM; INTERNATIONAL TRADE; PRICE.

SUPRARENAL GLAND. See GLAND (Adrenal Glands).

SUPREME COUNCIL OF THE ROYAL ARCANUM. See ROYAL ARCANUM, SUPREME COUNCIL OF THE.

SUPREME COURT OF CANADA. See CANADA, GOVERNMENT OF (The Supreme Court of Canada).

SUPREME COURT OF THE UNITED STATES is the highest court in the nation. One of its basic duties is to determine whether federal, state, and local governments are acting according to the Constitution of the United States. The Supreme Court does its job by deciding specific legal cases on the basis of established legal rules. Much of the court's work involves rules that are laid down in the Constitution. Although many of these rules are stated in words that are not entirely clear, the Supreme Court must determine their meaning and apply them to the cases presented for decision. For a discussion of the relationship between the Supreme Court and the Constitution, see the article GOVERNMENT (Constitutional Government).

A Supreme Court decision has great importance. Once a decision has been reached by the court, all other courts throughout the United States are required to follow the decision in similar cases. In this way, the Supreme Court helps guarantee equal legal justice to all Americans. The court is not required to consider every case presented to it. It accepts only a few, most of which involve problems of national importance.

The Supreme Court heads the judicial branch of the federal government. It is the only court specifically created by the Constitution. The judicial system of each state is also headed by a supreme court. In some states, the court is known by another name, such as *court of appeals*. For the most part, state courts hear cases concerning state laws. However, the U.S. Supreme Court may review the decisions of the highest state courts that involve the U.S. Constitution or acts of Congress. This article deals only with the U.S. Supreme Court. For information on the entire federal court system and on the state courts, see the article COURT.

The role of the Supreme Court and its interpretation of the law change occasionally. These changes depend partly on the political, social, and economic beliefs of its members, and partly on the national conditions of the time. In our early days as a nation, for example, the court concerned itself chiefly with the proper division of authority between the federal government and state governments. A major concern today is the protection of the rights and liberties of individuals.

William Ray Forrester, the contributor of this article, is Stevens Professor of Law at the Cornell University Law School, and the author of Cases and Materials on Constitutional Law. *The article was critically reviewed by Harry A. Blackmun, Associate Justice of the Supreme Court of the United States.*

How the Supreme Court Is Organized

Article III of the Constitution provides for the creation of the Supreme Court and states the limits of its jurisdiction. But details of the court's exact organization and the work it can do are left largely to Congress. Congress established the federal court system in the Judiciary Act of 1789.

Membership. The Supreme Court has nine members —a chief justice and eight associate justices. The exact number is set by Congress and has changed through the years. The first Supreme Court had six members. Since 1869, the court has consisted of nine members.

The Constitution sets no qualifications for justices but states that they shall be appointed by the President, with the advice and consent of the Senate. However, all members have had some legal training and experience, and most justices have been prominent judges, lawyers, law teachers, or government officials.

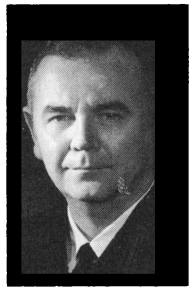
Through the years, the Senate has rejected outright only 11 Supreme Court nominees. About 15 other nominations have been postponed, not acted upon, or withdrawn. In 1969, Clement F. Haynsworth, Jr., of South Carolina became the first nominee since 1930 to be rejected by the Senate. The Senate also rejected G. Harrold Carswell of Florida in 1970. Both men had been nominated by President Richard M. Nixon.

From "Equal Justice Under Law"

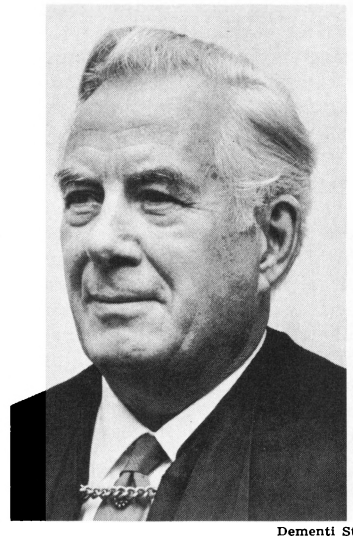
Courtroom of the Supreme Court Building in Washington, D.C., is shown here as the justices see it from the bench. Spectators sit in the rear of the courtroom. The space between the spectators and the bench is reserved for lawyers pleading cases, for other members of the bar, and for the press. The building, completed in 1935, was designed by Cass Gilbert.

THE SUPREME COURT

Harry A. Blackmun

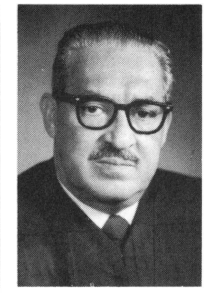


W. J. Brennan, Jr.



Chief Justice Warren E. Burger

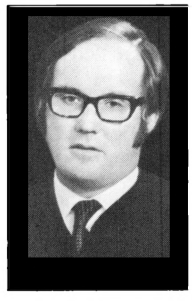
William O. Douglas



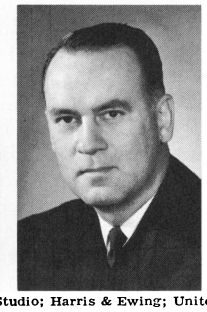
Thurgood Marshall

L. F. Powell, Jr.

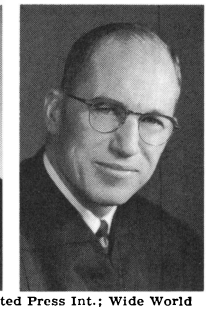
W. H. Rehnquist



Potter Stewart



Byron R. White



Dementi Studio; Harris & Ewing; United Press Int.; Wide World

Once appointed, justices may remain in office "during good behavior," and Congress cannot reduce their salary. These provisions protect the justices from political control and help ensure the independence of the court.

Salary and Terms. The court meets regularly in the Supreme Court Building in Washington, D.C. The annual term of the court begins the first Monday in October and usually ends in June.

The chief justice receives $62,500 a year, and each associate justice receives $60,000. A justice 70 years of age, who has served as a justice or judge of the United States 10 or more years, may retire and continue to receive his salary. A justice may retire at 65 if he has served at least 15 years as a justice or judge.

Authority of the Supreme Court

The Supreme Court declares what the law is only when an actual case comes before it. The case must involve a real dispute between opposing parties. The court does not give legal advice or advisory opinions, even if requested by the President or Congress.

The Constitution permits the court to decide cases "arising under" the Constitution, federal laws, and treaties. The court also decides disputes involving the United States or two or more states. The most important of these cases are those that require the court to interpret the Constitution or the laws enacted by Congress.

The Supreme Court has the power to decide whether a federal or state law or executive action is constitutional. This power, known as *judicial review*, is not expressly granted in the Constitution. However, the Constitution by its own terms is the "supreme law of the land." The court has ruled that it must review conflicts between the Constitution and a federal or state law.

Most of the work of the Supreme Court comes under its *appellate jurisdiction.* This is the authority to confirm or reverse the decisions of lower courts. Appellate courts can call a lower court decision up for review when requested to do so by the losing party. Most appeals are made on grounds that the judge has made an error in declaring the law that applies to the facts of the case. Most cases reviewed by the Supreme Court come from the federal courts of appeals and the highest state courts. The decisions of federal district courts are normally reviewed first by the courts of appeals. But in a few cases, the Supreme Court reviews the decisions of federal district courts directly. It also reviews the decisions of the federal Court of Claims, the Court of Customs and Patent Appeals, and the Supreme Court of Puerto Rico.

The Supreme Court may try a few types of cases from their beginning. This authority is called *original jurisdiction.* The court has original jurisdiction in cases ". . . affecting ambassadors, other public ministers and consuls, and those in which a state shall be party. . . ." These cases, however, make up only a small fraction of the court's workload.

The Court in Action

Accepting Cases. The Supreme Court cannot possibly review all the cases decided by lower courts. It can select only a few that it considers to be of sufficient importance. Questions of individual justice are most often left to the judgment of lower courts.

However, Congress has provided that the Supreme Court must grant review in a few types of cases. Such cases are brought to the court by *appeal.*

Most cases are brought before the court by a *writ of certiorari* (pronounced *SUR shee uh RAIR ee*). This is a

U.S. SUPREME COURT JUSTICES

Name	Term	Appointed By
CHIEF JUSTICES		
*John Jay	1790-1795	Washington
*John Rutledge	1795	†Washington
*Oliver Ellsworth	1796-1800	Washington
*John Marshall	1801-1835	J. Adams
*Roger B. Taney	1836-1864	Jackson
*Salmon P. Chase	1864-1873	Lincoln
*Morrison R. Waite	1874-1888	Grant
*Melville W. Fuller	1888-1910	Cleveland
*Edward D. White	1910-1921	Taft
*William H. Taft	1921-1930	Harding
*Charles E. Hughes	1930-1941	Hoover
*Harlan F. Stone	1941-1946	F. D. Roosevelt
*Frederick M. Vinson	1946-1953	Truman
*Earl Warren	1953-1969	Eisenhower
*Warren E. Burger	1969-	Nixon
ASSOCIATE JUSTICES		
*James Wilson	1789-1798	Washington
*John Rutledge	1790-1791	Washington
William Cushing	1790-1810	Washington
*John Blair	1790-1796	Washington
*James Iredell	1790-1799	Washington
*Thomas Johnson	1792-1793	Washington
*William Paterson	1793-1806	Washington
*Samuel Chase	1796-1811	Washington
Bushrod Washington	1799-1829	J. Adams
Alfred Moore	1800-1804	J. Adams
William Johnson	1804-1834	Jefferson
H. Brockholst Livingston	1807-1823	Jefferson
Thomas Todd	1807-1826	Jefferson
Gabriel Duvall	1811-1835	Madison
*Joseph Story	1812-1845	Madison
Smith Thompson	1823-1843	Monroe
Robert Trimble	1826-1828	J. Q. Adams
John McLean	1830-1861	Jackson
Henry Baldwin	1830-1844	Jackson
James M. Wayne	1835-1867	Jackson
Philip P. Barbour	1836-1841	Jackson
John Catron	1837-1865	Van Buren
John McKinley	1838-1852	Van Buren
Peter V. Daniel	1842-1860	Van Buren
Samuel Nelson	1845-1872	Tyler
Levi Woodbury	1845-1851	Polk
Robert C. Grier	1846-1870	Polk
Benjamin R. Curtis	1851-1857	Fillmore
John A. Campbell	1853-1861	Pierce
Nathan Clifford	1858-1881	Buchanan
Noah H. Swayne	1862-1881	Lincoln
Samuel F. Miller	1862-1890	Lincoln
*David Davis	1862-1877	Lincoln
*Stephen J. Field	1863-1897	Lincoln
William Strong	1870-1880	Grant
Joseph P. Bradley	1870-1892	Grant
Ward Hunt	1873-1882	Grant
*John M. Harlan	1877-1911	Hayes
William B. Woods	1881-1887	Hayes
Stanley Matthews	1881-1889	Garfield
Horace Gray	1882-1902	Arthur
Samuel Blatchford	1882-1893	Arthur
*Lucius Q. C. Lamar	1888-1893	Cleveland
David J. Brewer	1890-1910	Harrison
Henry B. Brown	1891-1906	Harrison
George Shiras, Jr.	1892-1903	Harrison
Howell E. Jackson	1893-1895	Harrison
*Edward D. White	1894-1910	Cleveland
*Rufus W. Peckham	1896-1909	Cleveland
Joseph McKenna	1898-1925	McKinley
*Oliver W. Holmes, Jr.	1902-1932	T. Roosevelt
William R. Day	1903-1922	T. Roosevelt
William H. Moody	1906-1910	T. Roosevelt
Horace H. Lurton	1910-1914	Taft
*Charles E. Hughes	1910-1916	Taft
*Willis Van Devanter	1911-1937	Taft
Joseph R. Lamar	1911-1916	Taft
Mahlon Pitney	1912-1922	Taft
*James C. McReynolds	1914-1941	Wilson
*Louis D. Brandeis	1916-1939	Wilson
John H. Clarke	1916-1922	Wilson
*George Sutherland	1922-1938	Harding
Pierce Butler	1923-1939	Harding
Edward T. Sanford	1923-1930	Harding
*Harlan F. Stone	1925-1941	Coolidge
*Owen J. Roberts	1930-1945	Hoover
*Benjamin N. Cardozo	1932-1938	Hoover
*Hugo L. Black	1937-1971	F. D. Roosevelt
Stanley F. Reed	1938-1957	F. D. Roosevelt
*Felix Frankfurter	1939-1962	F. D. Roosevelt
*William O. Douglas	1939-	F. D. Roosevelt
*Frank Murphy	1940-1949	F. D. Roosevelt
*James F. Byrnes	1941-1942	F. D. Roosevelt
*Robert H. Jackson	1941-1954	F. D. Roosevelt
Wiley B. Rutledge	1943-1949	F. D. Roosevelt
Harold H. Burton	1945-1958	Truman
*Tom C. Clark	1949-1967	Truman
Sherman Minton	1949-1956	Truman
*John M. Harlan	1955-1971	Eisenhower
*William J. Brennan, Jr.	1956-	Eisenhower
*Charles E. Whittaker	1957-1962	Eisenhower
*Potter Stewart	1958-	Eisenhower
*Byron R. White	1962-	Kennedy
*Arthur J. Goldberg	1962-1965	Kennedy
*Abe Fortas	1965-1969	Johnson
*Thurgood Marshall	1967-	Johnson
*Harry A. Blackmun	1970-	Nixon
*Lewis F. Powell, Jr.	1972-	Nixon
*William H. Rehnquist	1972-	Nixon

*Has a separate biography in WORLD BOOK.

†Appointment not confirmed by the United States Senate.

written order to call a case up from a lower court for review. The opposing attorney is given copies of the petition for certiorari and the supporting *brief* (written reasons for appeal). He has a short time to file a brief in opposition. If four justices vote to grant the petition, the court agrees to hear the case. The court partially controls its workload by granting only a small percentage of the requests for a writ of certiorari. In spite of this procedure, the court has a constantly growing volume of work. Legal experts have proposed the creation of an additional federal appeals court to relieve the Supreme Court's burden.

Pleading Cases before the Supreme Court is normally done by attorneys who have been admitted to the bar of the court. However, a *litigant* (person engaged in a lawsuit) may argue his own case. Each litigant usually hires and pays his own attorney. If a litigant has no money, free legal service may be provided.

When the U.S. government has an interest in a case before the Supreme Court, it is represented by the solicitor general or members of his staff. The attorney general of the United States may also argue important cases.

Deciding Cases. The justices decide a case after they have considered written and oral arguments from each side. During oral arguments, the justices are free to interrupt and to ask questions.

After the attorneys' oral arguments, the justices discuss the case *in conference* (in private). The chief justice begins the discussion. Then, in order of seniority, each associate justice gives his opinion. After discussion

ends, the justices vote in order of seniority. Cases are decided by majority vote.

If the chief justice has voted with the majority, he selects a justice to write the *opinion of the court*. This opinion is also called the *majority opinion*. If the chief justice has not voted with the majority, the senior justice of the majority assigns the opinion. A justice who disagrees with this opinion may write a *dissenting opinion*. A justice may write a *concurring opinion* if he agrees with the conclusion but not with the reasons for reaching it, or if he wishes to express similar reasons in his own words. Authors of the opinions announce them in a public session. All opinions are published in the *United States Reports*. The practice of putting opinions in writing requires the justices to explain and justify their decisions. The publishing of opinions also enables the public to know and understand the decisions of the court. This is an important tradition in a free society, and a safeguard against unreasonable use of power.

Effects of Decisions. Supreme Court decisions have importance far beyond the particular facts and parties involved. Once the court decides a case, lower courts are required to follow the decision in similar cases. The Supreme Court itself usually follows its earlier decisions. The policy of following rules laid down in previous decisions is known as *stare decisis*. This practice lends stability and predictability to the law.

The Supreme Court, however, is not bound by an earlier decision if it is convinced that an error has been made or that changed circumstances require a different approach. This provides for the court's recognition of social, political, and economic change.

Landmark Decisions

The Marshall Court. Many of the most important and historic Supreme Court opinions were written by John Marshall, one of the most famous of all American judges. Marshall served as chief justice from 1801 to 1835. The Supreme Court during those years is sometimes referred to as the "Marshall court."

Marshall's most historic opinion was written in 1803, in the case of *Marbury v. Madison*. His majority opinion stated that the court may rule an act of Congress unenforceable if the act violates the U.S. Constitution. This power of *judicial review* is *implied* (expressed indirectly) but not clearly granted in the Constitution. Some persons have protested vigorously against the court's exercise of judicial review. However, this power has become a basic part of the American constitutional system.

Several other Marshall court decisions also have had far-reaching application. In 1819, in *Dartmouth College v. Woodward*, the court ruled that private charters are contracts. It held that the Constitution protects such charters against violation by the states. This decision strengthened the rights of private property.

Also in 1819, in *McCulloch v. Maryland*, the court supported the doctrine of implied powers. It ruled that the federal government possesses powers in addition to those specifically granted in the Constitution. It said that the United States government has any powers that are necessary and proper in carrying out its specified powers. This decision of the court broadened the scope of the federal government. See MARSHALL, JOHN.

Regulating Commerce. An important concern of the court has been the proper relationship between government and business. The Constitution gives Congress the power to regulate interstate commerce. In 1824, in *Gibbons v. Ogden*, the Marshall court gave a broad interpretation to the word *commerce*. Since the mid-1930's, the court has interpreted the commerce clause in a way that gives Congress wide regulatory powers in matters affecting business. See INTERSTATE COMMERCE.

Civil Rights and Liberties. Through the years, the role and interpretations of the Supreme Court have shifted with changes in national conditions and public opinion. This has been true of the court's position on civil rights, especially in the area of race relations.

In 1857, in *Dred Scott v. Sandford*, the court held that Negroes were not and could not become U.S. citizens. But the 14th Amendment to the Constitution (1868) made all former slaves citizens and gave them full civil rights. In 1896, in the case of *Plessy v. Ferguson*, the court upheld a law providing for "separate but equal" public facilities for Negroes and whites. But in 1954, in *Brown v. Board of Education of Topeka*, the court ruled that racial segregation in public schools is unconstitutional. In the 1969 case of *Alexander v. Holmes County* (Miss.) *Board of Education*, the court ordered that public school systems end segregation "at once." In 1964, in *Heart of Atlanta Motel, Inc. v. United States*, the court upheld the Civil Rights Act of 1964. This act prohibits racial discrimination in many public accommodations.

Several cases in the 1960's dealt with voting rights. In 1962, the court ruled in *Baker v. Carr* that unfair districting of state legislatures could be challenged in federal courts. It ruled in other cases that congressional districts must be about equal in population and that state legislatures and local governing bodies must be apportioned on the basis of equal population.

Other decisions have dealt with the rights of persons accused of crimes. In 1964, in *Escobedo v. Illinois*, the court ruled that a confession cannot be used as evidence if it is obtained after the defendant has been denied permission to see his lawyer. In the 1966 case of *Miranda v. Arizona*, the court held that prior to any questioning, the defendant must be informed of his constitutional rights, including the right to remain silent. In *Witherspoon v. Illinois* in 1968, the court held that defendants cannot be sentenced to death by juries from which persons who oppose capital punishment have been automatically excluded. In the 1972 case of *Furman v. Georgia*, the court ruled that capital punishment, as then administered in the United States, was unconstitutional.

Several cases of the 1970's dealt with the rights of women and children. In the 1973 cases of *Roe v. Wade* and *Doe v. Bolton*, the court ruled on women's right to have an abortion. It declared that a state may not prohibit abortion, under certain conditions, during the first six months of pregnancy (see ABORTION). In 1975, in *Goss v. Lopez*, the court held that public schools cannot suspend pupils without notice of the charges against them and a fair hearing. In the 1975 case of *Taylor v. Louisiana*, the court ruled that excluding women from juries was unconstitutional.

Other important civil rights decisions of the court have dealt with Bible reading and prayers in public schools, freedom of speech and of the press, and pretrial

LANDMARK DECISIONS OF THE SUPREME COURT

The following cases represent some of the most important rulings made by the Supreme Court of the United States.

POWERS OF THE COURT, FEDERAL GOVERNMENT, AND STATES

1803 **Marbury v. Madison.* If a law passed by Congress conflicts with the Constitution, the Supreme Court must base its decision on the Constitution. This ruling established the court's power of *judicial review*—that is, its authority to declare laws unconstitutional.

1810 **Fletcher v. Peck.* Georgia could not revoke a land grant after the land had been sold to a third party. The Constitution protects contracts against interference by the states, and a sales agreement is a type of contract.

1819 **McCulloch v. Maryland.* The Constitution gives *implied powers* to the federal government in addition to the *express powers* that are specifically granted. Implied powers are those necessary to carry out express powers.

1819 **Dartmouth College v. Woodward.* New Hampshire could not alter a royal charter and make Dartmouth a state college. A charter is a contract, and the Constitution protects contracts against state interference.

POWERS OF THE PRESIDENT

1952 *Youngstown Sheet and Tube Company v. Sawyer.* The President exceeded his lawful power when he seized the nation's steel mills to prevent a strike during the Korean War.

1974 *United States v. Richard M. Nixon.* The President cannot withhold evidence needed in a criminal trial. This ruling established that the President's *executive privilege*—his right to keep records confidential—is not unlimited.

REGULATION OF BUSINESS AND INDUSTRY

1824 **Gibbons v. Ogden.* The powers of the federal government are superior to those of the states in all matters of *interstate commerce* (trade between states).

1905 **Lochner v. New York.* A law limiting bakers to a 60-hour work week was unconstitutional because it violated "freedom of contract" between employer and employee. The court reversed this decision in 1937.

1935 **Schechter Poultry Corporation et al. v. United States.* The National Industrial Recovery Act of 1933, which provided for the establishment of fair-competition codes for businesses, was unconstitutional.

1937 *National Labor Relations Board v. Jones and Laughlin Steel Corporation.* The federal government has the power to regulate the local activities of labor unions because these activities may affect interstate commerce.

ELECTION DISTRICTS

1962 *Baker v. Carr.* Citizens can challenge unfair election districting before a federal court.

1964 *Reynolds v. Sims.* The U.S. House of Representatives and both houses of a state legislature must follow the rule of "one person, one vote" and create election districts roughly equal in population.

FREEDOM OF SPEECH AND OF THE PRESS

1919 *Schenck v. United States.* The government cannot restrict freedom of speech unless the speech creates a "clear and present danger" of violence or some other evil that the government has a right to prevent.

1957 *Roth v. United States.* Freedom of the press, guaranteed by the First Amendment to the Constitution, does not protect publication of obscene material.

1964 New York Times *v. Sullivan.* A newspaper cannot be punished for untrue statements about a public official unless it deliberately published a falsehood.

1971 New York Times *v. United States.* The government could not prevent publication of the *Pentagon papers,* a secret study of the Vietnam War. The court held that the danger to national security did not justify such censorship.

1973 *Miller v. California.* Material can be considered obscene if it fulfills certain requirements established by the court (see OBSCENITY AND PORNOGRAPHY).

SCHOOL PRAYER

1962 *Engel v. Vitale.* Prayers and devotional Bible readings in the public schools are unconstitutional.

RIGHTS OF PERSONS ACCUSED OF CRIME

1866 **Ex Parte Milligan.* Civilians cannot be tried by military courts outside military areas if civilian courts are available.

1932 *Powell v. Alabama.* If a person on trial for his life cannot hire a lawyer, the state must provide one. The legal help must be furnished in time to help prepare the case effectively.

1961 *Mapp v. Ohio.* Evidence obtained by illegal means cannot be used in a criminal trial.

1963 *Gideon v. Wainwright.* The states must provide free legal counsel to any person accused of a felony who cannot afford a lawyer.

1964 *Escobedo v. Illinois.* A confession cannot be used as evidence if it is obtained after the accused person has been denied permission to see his lawyer.

1966 *Miranda v. Arizona.* An accused person must be informed of his constitutional rights, including the right to remain silent, before he is questioned.

1972 *Argersinger v. Hamlin.* The states must provide free legal counsel to any person accused of a misdemeanor that involves a jail sentence if the person cannot afford a lawyer.

1972 *Furman v. Georgia.* The death penalty, as it was then administered, was cruel and unusual punishment in violation of the Eighth Amendment to the Constitution.

RIGHTS OF MEMBERS OF MINORITY GROUPS

1857 **Dred Scott v. Sandford.* Negroes could not be U.S. citizens, and Congress could not prohibit slavery in the U.S. territories. The first part of this ruling was overturned in 1868 by the 14th Amendment to the Constitution. The second part was struck down in 1865 by the 13th Amendment.

1896 **Plessy v. Ferguson.* "Separate but equal" public facilities for whites and blacks did not violate the Constitution. The court reversed this decision in 1954.

1944 *Korematsu v. United States.* The government could lawfully remove persons of Japanese ancestry from areas threatened by Japanese attack during World War II.

1946 *Morgan v. Virginia.* Interstate buses cannot segregate passengers according to race.

1948 *Shelley v. Kraemer.* State or federal courts cannot enforce *restrictive covenants,* which are agreements to prevent real-estate owners from selling their property to members of minority groups.

1954 *Brown v. Board of Education of Topeka* (Kans.). Separate but equal facilities for Negroes in public schools do not meet the constitutional requirement for equal protection of the law.

1964 *Heart of Atlanta Motel, Inc. v. United States.* The Civil Rights Act of 1964 is constitutional. This act bans racial discrimination in all public accommodations that affect commerce, including hotels, motels, and restaurants.

1969 *Alexander v. Holmes County* (Miss.) *Board of Education.* Desegregation of all public school systems must take place "at once."

RIGHTS OF WOMEN

1973 *Doe v. Bolton* and *Roe v. Wade.* The states may not prohibit a woman's right, under certain conditions, to have an abortion during the first six months of pregnancy.

*Has a separate article in WORLD BOOK.

publicity that is *prejudicial* (unfair) to the accused.

A table with this article describes many of the court's landmark decisions. See also GRANGER CASES.

Controversy on the Court

The Supreme Court has been sharply divided on some cases brought before it. This has been especially true of cases involving questions that have divided the American public, such as minority rights. The court's lack of complete agreement in such cases is not unexpected nor undesirable. It reflects the seriousness of the cases and the presence of different points of view.

Since the Supreme Court was established, a strong debate has continued concerning the extent of its power. One side has insisted that the court should interpret and apply the Constitution to agree with the meaning and intent of those who wrote it. Another group has insisted on a more creative role for the court. They would interpret the Constitution so that it would apply to the new and changing problems of the nation. The second group also draws support from the original intent of the founding fathers, but disagrees as to the scope and meaning of that intent.

The Supreme Court possesses great power over the Constitution and the nation. But this power is based on the respect of the American people. Throughout most of its history, the court has held the streams of government within their proper channels. It has largely succeeded in the delicate task of protecting the rights of unpopular minorities while relying for its support on the approval of the majority. WILLIAM RAY FORRESTER

Critically reviewed by HARRY A. BLACKMUN

See the separate articles in WORLD BOOK for the justices and the landmark decisions listed in the *tables* in this article. See also CHIEF JUSTICE; COURT; ROOSEVELT, FRANKLIN D. (The Supreme Court); CONSTITUTION OF THE UNITED STATES; WASHINGTON, D.C. (picture: The Supreme Court Building). For a *Reading and Study Guide*, see *Supreme Court of the United States*, in the RESEARCH GUIDE/INDEX, Volume 22.

SUPREME SOVIET. See RUSSIA (Government).

SURABAYA, *soor uh BAH yuh* (pop. 1,556,255), is the second largest city in Indonesia. It lies along the Kali Mas, a river in eastern Java, about 420 miles (676 kilometers) east of Jakarta (see INDONESIA [color map]). It is a major port and naval base, and has shipbuilding, textile, chemical, and petroleum industries.

SURCHARGE. See INCOME TAX (introduction).

SURETY BOND. See BONDING.

SURFACE MEASURE. See SQUARE MEASURE.

SURFACE TENSION is a force that causes the surface of liquids to behave in certain ways. It causes a liquid to behave as if a thin, elastic film covered its surface. For example, the surface of water can support needles and razor blades if they are placed there carefully.

Surface tension also causes a liquid to rise in a thin tube when the tube is dipped in the liquid. This action is called *capillarity* (see CAPILLARITY).

Because of surface tension, drops of liquid take a spherical shape, which has the smallest possible surface area. For example, raindrops fall as spheres.

Surface tension is caused by *cohesion*, a force that causes the molecules of a substance to be attracted to one another (see COHESION). The molecules of a liquid that are below the surface have molecules pulling on them from all directions. But the molecules on the surface are attracted only by the molecules below and to their sides. The downward and sideward attraction of the molecules creates a constant pull on the surface molecules, causing surface tension. E. D. GODDARD

SURFING is a thrilling water sport for persons of all ages. In *surfboard riding*, the surfer stands on a board that skims along the *crest* (top) of a wave. However, body surfers are swept along by the wave without using a board. Both kinds of surfing demand split-second timing. The surfer must have sharp reflexes to maintain the delicate balance he needs for a thrilling ride.

Surfers usually train for surfboard riding by body surfing. To body surf, a surfer swims out from the shore and waits for a high wave. When a high wave starts in toward the shore, he does a *scissors kick* (spreads his legs apart and kicks them together) in the direction of the shore and swims a few strokes at the crest. He then puts his head down, arches his back, and puts his hands at

Catching A Wave, the surfer paddles with his hands to gain speed. When the wave lifts the board, he stands up and puts his weight on his front foot, aiming the board toward the shore.

Don James

Surfing requires good balance and quick reflexes. The two men on the right are riding a wave into shore. The man on the left is paddling out to catch another wave. Surfers should be good swimmers.

his sides. The wave sweeps him toward shore in this position. As it dies out, the surfer pushes his hands out and spreads his legs to slow down. The feel of the surf and the sense of balance gained is good training for surfboard riding.

For a surfboard ride, the surfer lies on his stomach on the board and paddles out to the area where the waves build up. When a big wave starts in toward shore, the surfer paddles his board ahead of it. As the wave begins to carry the board toward shore, the surfer stands up. He tries to guide the board across the face of the wave by shifting the weight of his body. Expert surfers may move to the front of the board, but most surfers stand at the middle or rear of the board to keep it from turning over. A long rolling wave will bring a surfer onto the sands of the shore. The bigger the wave, the better the ride will be.

Surfing began in Hawaii hundreds of years ago. The sport is now popular in most parts of the world. Surfing in the United States centers on the beaches of Hawaii and southern California. Many styles of surfboards are used, but most U.S. surfers use a fiberglass board that is tapered at both ends. It is about 10 feet (3 meters) long, 30 inches (76 centimeters) wide, 3 inches (8 centimeters) thick, and weighs from 8 to 15 pounds (3.6 to 6.8 kilograms).

SAM J. GRELLER

See also HAWAII (color picture: Riding the Surf).

SURFING TERMS

Backwash, Rip, or **Riptide** is a current that reverses itself and moves out from the shore.

Big Gun is a heavy surfboard used on big waves.

Break is the point in shallow water where a wave slows and builds up, then scatters.

Cornering occurs when a surfer shoots across a wave at an angle to the shoreline.

Crack a Wave means to ride a big wave successfully.

Dumper, or **Fall** is a wave that builds up sharply and drops straight down into shallow water.

Going Down the Mine occurs when a surfer misses the proper take-off point in a wave and is thrown in front of the wave.

Green Wave is a long, uninterrupted wave.

Hanging Five, or **Ten** occurs when the surfer hooks his toes over the end of the board.

Hot Dogger is an expert surfer who can do gymnastic and balancing tricks on the board.

Howler, or **Zipper** is a big wave that only an expert can ride.

Pig Board, or **Tear Drop** is a board shaped like a pie wedge.

Roller is a long, smooth wave that rolls to the shore.

Wipe Out occurs when a rider is bumped from a board by a wave.

SURGEON. See SURGERY; MEDICINE.

SURGEON BIRD. See JAÇANA.

SURGEONFISH. See DOCTORFISH.

SURGEONS, AMERICAN COLLEGE OF, is an organization of surgeons of the United States and Canada. Its purposes are to advance the science and art of surgery and to improve the surgical care of patients. The organization holds regional meetings each year. Its annual Clinical Congress is the world's largest gathering of surgeons at which scientific papers and exhibits are presented. The official surgical journal of the College is *Surgery, Gynecology & Obstetrics*. The college was founded in 1913 and has more than 32,000 members in about 100 countries. Headquarters are at 55 E. Erie Street, Chicago, Ill. 60611.

Critically reviewed by the AMERICAN COLLEGE OF SURGEONS

SURGEONS, INTERNATIONAL COLLEGE OF, is an organization of qualified surgeons that was founded in 1935 in Geneva, Switzerland. Its purpose is to improve and spread surgical knowledge throughout the world. About 15,000 surgeons in more than 70 countries belong to the organization. There are regional federations in Africa, Asia, Europe, Latin America, North America, and the South Pacific. The organization publishes a monthly journal and bulletin. Headquarters and an International Museum of Surgical Sciences are at 1516 N. Lake Shore Drive, Chicago, Ill. 60610.

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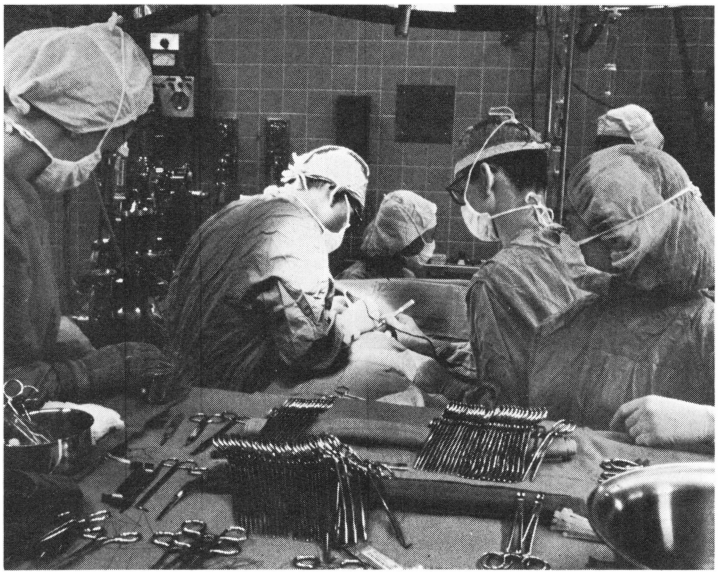

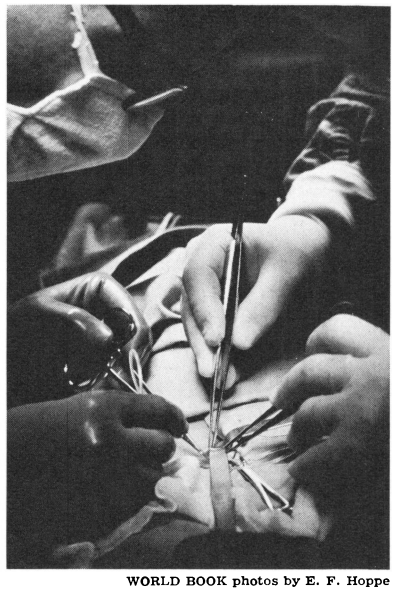

WORLD BOOK photos by E. F. Hoppe

Modern Surgery is a team effort, *left*. A surgeon and his assistant perform the operation, *right*, while nurses keep them supplied with instruments. An anesthesiologist completes the team.

SURGERY is the branch of medicine that deals with the treatment of disease, deformities, or injuries by operations. The doctor who performs the operation is called a *surgeon*. Every physician has some training in surgery and is qualified to perform simple operations. But the surgeon is specially trained so that he has the judgment and skill to perform complicated operations. Four or five years of additional training after internship are necessary to qualify a doctor for general surgery. The doctor may train even longer if he wishes to enter one of the special fields of surgery.

The Surgeon's Tools

A surgical operation is complicated. Many persons, medicines, and techniques are used to assure the greatest safety and comfort for the patient and to help the surgeon in his work. Anesthesia, the prevention of infection, and many laboratory tests are important aids to the surgeon. A qualified *surgical team* is essential to the successful performance of an operation. This team usually consists of at least a surgeon, a first assistant, an anesthesiologist, and a nurse.

Anesthesia. Before the discovery of anesthesia in 1842, operations were very painful. Because of this, surgeons could perform only very short operations. They tried to deaden the pain by giving large quantities of wine or other alcoholic beverages. Sometimes compounds containing opium were used. But the relief from pain was not complete and lasted only a short time.

Since the discovery of anesthesia, researchers have studied drugs and gases and developed more satisfactory anesthetics. Numerous *general anesthetics*, such as nitrous oxide, ether, and halothane, are used to put the patient to sleep. These may be used alone or in combination with one another. General anesthesia is also produced by injecting drugs such as sodium pentothal (see SODIUM PENTOTHAL). Sometimes a *local anesthetic*, such as Novocain, which affects only the area near the place of injection, is used (see NOVOCAIN). Local anesthetics injected into the spinal canal produce anesthesia in specific parts of the body. One drug, curare, was used centuries ago by South American Indians (see CURARE). They put the drug on the tips of their arrows to paralyze or kill small animals and birds. Modern surgeons use it to relax the abdominal muscles in many serious operations. See ANESTHESIA.

Antiseptics and Asepsis. Infection once was a great danger in surgery. Even though the surgery was successful, patients often died because of infection. But in 1865, Joseph Lister of Great Britain introduced methods for preventing infection. He used various antiseptics to kill germs in the operating room during the course of an operation. He often sprayed carbolic acid about the room to kill the germs. Later, the method of *aseptic* (completely sterile) surgery was developed. In this method all germs that cause infection are kept out by cleaning and sterilizing all equipment used in the operating room. Instruments and linens are completely sterilized before the operation. Thus, while antiseptics kill germs that are present, asepsis keeps them out altogether. See ANTISEPTIC; LISTER, SIR JOSEPH.

Instruments. A surgeon uses many instruments in the course of a single operation. Sharp instruments include scissors and *scalpels* (knives). There are also holders for needles and sponges, *clamps* to close off blood vessels, *retractors* to hold back folds of skin, and many others.

Modern instruments have advanced the growth of surgery. Perhaps one of the most useful of these, the X-ray machine, is seldom thought of as an "instrument." But this device, which permits the doctor to see inside the human body, is probably one of the most valuable tools for diagnosis. By this means, the surgeon

can detect broken bones, and diagnose many of the important diseases of the internal body organs. Other instruments have been useful in looking into body cavities. The *bronchoscope* is used to examine the lungs, and to perform a *biopsy* (remove small pieces of lung tissue for study and diagnosis). Doctors use the *cystoscope* to examine the bladder. A modern surgical knife uses very short radio waves to cut body tissues.

Sutures are threads used to tie severed blood vessels and to close surgical wounds so that the tissues heal better. Modern surgery would be impossible without them. Some kinds of sutures, such as catgut, are absorbed by the body. Others, such as nylon or silk, must be removed after several days. See SUTURE.

Technique. In the early days of surgery, the operator's technique was considered most important. Only the most skilled surgeon could perform an operation in the least possible time. For example, these doctors could perform an amputation in two or three minutes. Modern surgery stresses adequate diagnosis of the disease and proper care of the patient before and after the operation. Thus, the surgeon needs not only knowledge of surgery itself, but also a wide knowledge of physiology, chemistry, and pathology. However, technique remains an important tool in surgery.

In 1874, a leading British surgeon spoke of "those portions of the human frame that will ever remain sacred." He said that "the abdomen, the chest, and the brain would be forever shut from the intrusion of the wise and humane surgeon." Since that time, the surgeon has been able to operate successfully upon all parts of the human body, including these. For example, a present-day surgeon can remove a long section of diseased intestines and sew the remaining intestinal sections together. The body will function normally after the operation. A kidney, or even a major part of the stomach, can be removed by an operation. Surgeons have been able to operate successfully on the heart. In such surgery, a doctor may lift the heart out of the body, operate on it, and then replace it. Extensive surgery on the lungs and ribs is often part of the treatment of tuberculosis. A surgeon can successfully remove an entire lung that has been diseased by cancer. A brain surgeon can remove brain tumors, repair head injuries, and cut nerves to correct certain conditions.

Transplanting organs is one of the newest types of operations. In this operation, the surgeon takes a healthy organ from one person and uses it to replace the diseased organ in another person. But the tissues must be able to exist together, or the patient's body will reject the new organ. See TISSUE TRANSPLANT.

Cryosurgery makes use of extreme cold in surgery. It usually involves freezing tissues. Cryosurgery has been suggested to cure duodenal ulcers. Surgeons sometimes use cold probes on the brain to treat Parkinson's disease. Cold probes are also used to treat detached retinas and remove cataracts. See CRYOBIOLOGY.

A Typical Operation

Perhaps the best way to understand what is involved in a surgical operation is to consider a typical one. After a thorough examination, including laboratory

SOME COMMON SURGICAL OPERATIONS

Amputation is the removal of a limb (or part of a limb) or another appendage. Usually performed if a limb is damaged beyond repair, or if a seriously diseased appendage resists treatment and threatens to infect other parts of the body. See AMPUTATION.

Appendectomy is the removal of the vermiform appendix. Commonly performed in cases of appendicitis (see APPENDICITIS).

Cholecystectomy is the removal of the gall bladder. Generally performed if the gall bladder is seriously inflamed or if it contains gallstones that affect the patient's health. See GALL BLADDER.

Colostomy is the creation of an artificial opening in the *colon*, a part of the large intestine. Usually performed if the rectum is diseased or has been removed. Solid body waste passes through an artificial opening made in the wall of the abdomen.

Gastrectomy is the removal of part or all of the stomach. Commonly performed to remove cancerous tissue or peptic ulcers.

Hysterectomy is the removal of the *uterus* (womb). Usually performed to treat any of various uterine diseases, including cancer. Hysterectomy does not affect sexual desire or function, but it does cause sterility.

Mastectomy is the removal of part or all of a breast. Commonly performed to remove diseased tissue, especially cancerous tissue. *Radical mastectomy* includes the removal of additional muscle and *axillary* (armpit) tissue.

Nephrectomy is the removal of a kidney. Generally performed to remove cancerous tissue or a kidney that no longer functions properly. Removal of one kidney causes no disability. But removal of both kidneys results in death, unless the patient receives a kidney transplant or undergoes *dialysis* (regular treatments with an artificial kidney machine).

Oöphorectomy is the removal of an ovary. Usually performed to remove diseased tissue, such as a cancerous tumor. Removal of both ovaries causes *menopause* (the end of menstruation) and prevents the patient from having children.

Pneumonectomy is the removal of lung tissue. Commonly performed to remove cancerous tissue; occasionally to remove a long-term abscess or infection. *Total pneumonectomy* is the removal of an entire lung.

Prostatectomy is the removal of part or all of the prostate gland. Commonly performed to remove cancerous tissue or an enlarged prostate that interferes with the flow of urine from the bladder.

Tonsillectomy is the removal of the tonsils. Generally performed in cases of long-term or recurring infection. See TONSILLITIS.

Tracheotomy is the creation of an artificial opening leading from the *trachea* (windpipe) to the outside of the body. Commonly performed to enable a patient with a blocked larynx to breathe.

Vasectomy is the cutting and tying of the *vasa deferentia*, the tubes that carry sperm from the testicles. Usually performed to cause sterility. Vasectomy does not affect sexual desire or function.

tests, the doctor diagnoses the disease as an infected appendix. The patient is brought to the hospital and prepared for the operation. Sedative drugs are given to relax the patient before the operation.

The operating room has been prepared for the patient's arrival by a thorough cleaning and scrubbing. All equipment not to be used for the operation has been removed. A large table is set up near the operating table. This will hold all the sterilized instruments and sponges that the surgeon might need during the operation. A second table, a small one on an L-shaped stand, is also set up. This fits over both the operating table and the patient. It holds all the instruments and sponges immediately needed by the surgeon. A nurse or an operating room technician has charge of these tables.

The patient is usually put to sleep in a room that is designed for this purpose. The anesthesiologist needs a lot of equipment such as anesthetics, anesthetic machines, masks, sterile syringes, a stethoscope, and an apparatus that measures blood pressure. A tank of oxygen and a mask for giving the gases are always present. Also at hand are small flasks of stimulant drugs.

Meantime the doctors and nurses on the surgical team prepare for the operation. They spend 8 to 10 minutes scrubbing their hands and forearms to remove germs. In addition to this, they wear sterilized rubber gloves because the skin cannot be made completely sterile even with strong antiseptics. The members of the surgical team put on sterilized gowns to cover their clothing and caps to cover their hair. They also wear masks of gauze or other material to cover their mouths and noses so that they will not breathe germs into the area.

Nurses and orderlies bring the patient into the operating room and make him comfortable on the operating table. The anesthesiologist takes and records the rate of the patient's pulse, respiration, and blood pressure. He keeps a constant check on these throughout the operation. Nurses place sheets over the patient in such a manner that the area in which the *incision* (opening) is to be made is left open. This area is thoroughly cleansed, antiseptics are applied, and the area is again draped with sterile sheets. Nurses place the sterile instruments on the tables, and put the small table over the operating table, within easy reach of the surgeon. If gas is the anesthetic, the anesthesiologist places a mask over the patient's face and opens the valves of a complicated machine, thus allowing the patient to breathe the anesthetic. He soon feels no pain.

The surgeon starts the operation by making an incision in the skin of the abdomen. He extends this through the layer of fat that lies directly beneath the skin. He pulls back the muscle tissue, and places retractors in position to hold the tissue out of the way. This exposes the appendix and that part of the intestine to which it is attached.

As he works, the surgeon closes the severed ends of small blood vessels with clamps called *hemostats*. Thus very little bleeding takes place during the operation. *Sponges*, which are actually pieces of gauze folded into small pads, are used to remove any surplus blood. The surgeon quickly removes the appendix, ties the stump that remains with a suture and *inverts* (turns) the stump into the large intestine. Then the "closing-up" procedure begins.

The sponges are removed. The surgeon takes the clamps off the blood vessels and ties the vessels so there will be no bleeding. He then removes the retractors, and the muscles move back into their normal position. The surgeon brings the tissues together with sutures. Finally, he sews the edges of the cut skin together.

During the course of the operation, the anesthesiologist has been careful to give exactly the right amount of anesthetic to the patient. The various nurses assist the surgeon like members of any well-drilled team.

At the end of the operation, the doctor applies a gauze bandage to the incision area and nurses remove the sheets used for draping. Doctors and nurses return the patient to his hospital bed and he usually recovers uneventfully. Yet such a routine operation would have been impossible a hundred years ago.

Surgical Specialties

As in other branches of medicine, special branches of surgery have developed. These specialties came about because of the need for specialized types of surgery for specific areas of the body. Surgeons in these fields often take additional training. Frequently, new equipment is developed for use in the specialty fields.

Ophthalmology, a specialty in treating diseases of the eyes, has developed a distinct field of surgery. Surgeons cure blindness that results from *cataracts* (a clouding of the eye lens) by removing the lens. They also operate on the muscles of the eye to correct a condition known as cross-eyes. See OPHTHALMOLOGY.

Plastic Surgery can produce exceptional results by removing scars and blemishes. Plastic surgeons often graft skin. World War II gave great impetus to the development of plastic surgery. Men who were seriously disfigured in battle had their deformities corrected by means of surgery. Surgeons made new noses or new ears even though the original ones were completely destroyed. They built new jaws from living bone and cartilage and flesh. See PLASTIC SURGERY.

Gynecology and Obstetrics are related surgical specialties that deal with women's diseases and childbirth, respectively. The Caesarean section in childbirth once resulted in the death of about 86 of every 100 women on whom it was performed. In most modern hospitals, not even two die of every 100 women on whom such operations are performed.

Other Specialty Fields. There are many other fields in which special types of surgery have developed. The *thoracic* surgeon operates on the chest. In *urologic* surgery, the surgeon operates on the kidneys and bladder. The *otolaryngologist* takes care of diseases of the ears, nose, and throat. The *orthopedist* operates on bones. The *proctologist* treats diseases of the lower bowel and anus. *Brain surgeons* and *heart surgeons* need particular skills and training. In each field, new knowledge and techniques have brought great progress (see HEART [Heart Surgery]).

History

Surgery has been known since ancient times. The first surgeon's tool was probably a piece of flint stone. Some skeletons of Stone Age men show evidence of *trephining*. In this operation, a hole was cut in the

head of the patient to relieve pressure from a fracture. Primitive tribes fixed broken legs with splints. Even in the earliest times, *cautery* (searing the flesh) was used to stop bleeding. Circumcision, performed during certain religious rites, was one of the earliest operations.

Some operations were known to the ancient Babylonians, Greeks, and Romans. Military surgery has been important for two or three thousand years. The early Hindus were expert surgeons. They knew at least 125 different surgical instruments. They also developed plastic surgery to replace noses and ears that had been cut off. In the Middle Ages, surgeons were often confused with barbers. Both performed operations. But only the barber did bloodletting, for the surgeon thought it beneath him. It is from this bloodletting that the red and white striped barber pole developed—the red standing for blood and the white for the bandage.

Among the many famous surgeons of the past was the Frenchman, Ambroise Paré, who lived in the 1500's. He has been called the father of military medicine. He abolished the harmful practice of pouring boiling oil on wounds to sterilize them. John Hunter (1728-1793), an English pathologist, was the founder of experimental surgery. In the United States, Ephraim McDowell (1771-1830) of Kentucky performed the first successful operation to remove a tumor of the ovary in 1809, the beginning of successful abdominal surgery. Crawford Long (1815-1878) of Georgia is credited with having first used ether as an anesthetic in 1842.

Many of the great modern surgeons have been Americans. William Halsted (1852-1922) devised many new surgical procedures and techniques. He introduced the use of sterile gloves in aseptic surgery. Fred H. Albee (1876-1945), an orthopedist, brought bone grafting into practical use. Chevalier Jackson (1865-1958) developed the first practical lighted *esophagoscope*, an instrument used to examine the *esophagus* (the food passage between the mouth and stomach). Other modern surgeons are the famous Mayo brothers, William and Charles, both of whom made many contributions; Harvey Cushing, the great brain surgeon; and Evarts Graham. This pioneer thoracic surgeon in 1933 became the first to successfully remove an entire cancerous lung.

Modern surgery has advanced in five main ways. These are (1) the development of aseptic surgery; (2) the technical improvements in surgical instruments; (3) the increased knowledge of body processes; (4) anesthesia; and (5) the use of chemicals to prevent and treat infections.

WARREN H. COLE

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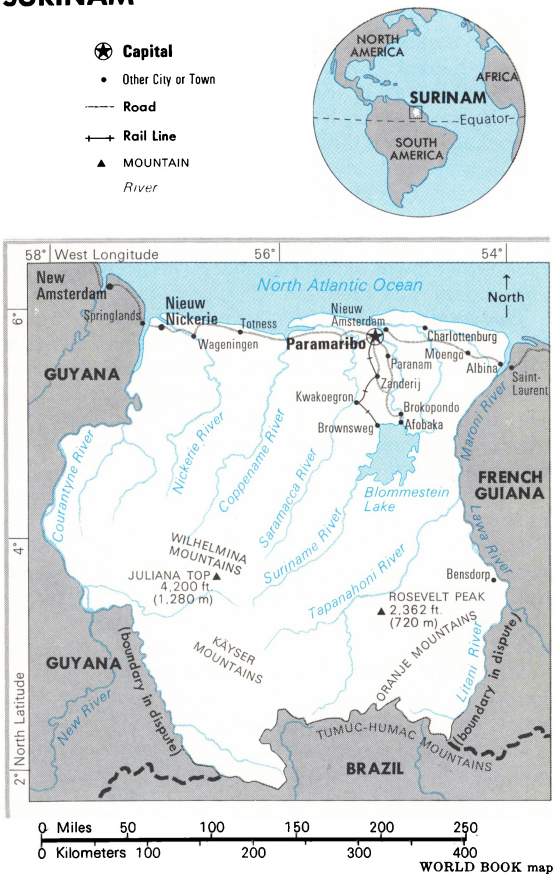


WORLD BOOK map

SURINAM, *SOOR uh nam*, is an overseas territory of The Netherlands. It is also called DUTCH GUIANA. Surinam lies on the northeastern coast of South America, between Guyana and French Guiana. Dense mountain forests separate Surinam from Brazil on the south. Surinam covers 63,037 square miles (163,265 square kilometers). Paramaribo is the capital and largest city of the territory (see PARAMARIBO).

The coast of Surinam is flat swampland. The inhabited sections along the lower parts of the rivers are protected by dams and drained by canals. Swamps and forests limit agriculture almost entirely to these regions. Mountains and thick forests cover the interior of the country. Interior forests yield dyewoods, and hardwoods such as mahogany and Surinam teak.

The People and Their Work. Surinam has a population of about 473,000, including about 41,000 Negroes and American Indians who live in the interior. The *Bush Negroes* are descendants of African slaves who escaped into the jungles before slavery was abolished in the mid-1800's. Indians who descended from the earliest Indian settlers live along the rivers in the interior. People from India, Indonesia, and descendants of Negro slaves form the largest population groups. Dutch is the official language of Surinam.

Agriculture and mining are the chief industries. Farm products include bananas, cacao, citrus fruits, coffee, maize, rice, and sugar. Surinam has vast deposits of

bauxite, a mineral used in making aluminum, and is a leading bauxite producer (see ALUMINUM [table]). During World War II, Surinam provided over half the bauxite used by the United States. In the mid-1960's, Afobaka Dam was built on the upper Suriname River to supply power for the Suralco Company's aluminum smelter and alumina plant.

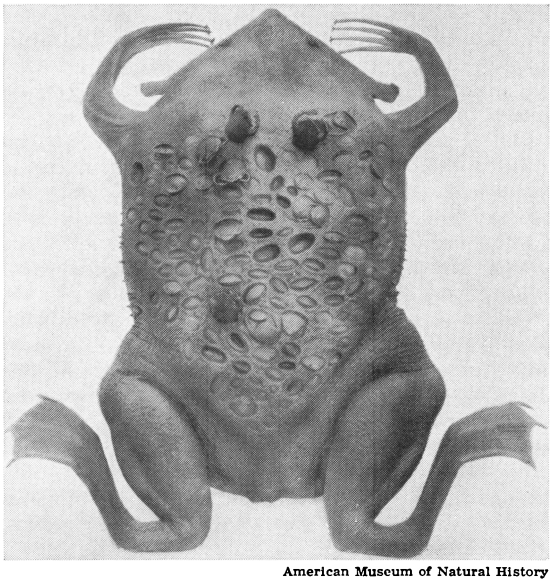
Cities. The chief cities of Surinam are Paramaribo (the largest city), Moengo, Nieuw Nickerie, and Totness. Other towns include Albina, Kwakoegron, Nieuw Amsterdam, and Paranam.

Government and History. Surinam is governed under the constitution of 1950. In 1955, The Netherlands gave Surinam complete control over its domestic affairs but retained control of foreign affairs and defense. The Dutch monarch appoints a governor for Surinam. He serves an indefinite term. A 21-member legislative council, elected by the people, serves a four-year term.

The English settled the area in 1651. By the Treaty of Breda, ending an Anglo-Dutch war in 1667, Great Britain gave the area to the Dutch in exchange for what is now New York state. The English occupied the area during the Napoleonic Wars, but Surinam reverted to the control of the Dutch government after the wars ended in 1815. ARTHUR P. WHITAKER

SURINAM TOAD is an odd-shaped toad that is known for the unusual way it raises its young. It is named for Surinam (Dutch Guiana), in South America, where man first discovered it. The Surinam toad is flat, and has a head shaped like a triangle. It has small eyes, and no tongue or teeth. The long, thin fingers of its front legs are not webbed, but its hind feet have large webs between the toes.

The Surinam toad lives in the water and has rough, brown skin. At breeding time, the female's skin grows thick and spongy. The female lays each egg while she and her mate turn over in the water. The egg sinks into the skin of the female's back. The young pass the tadpole stage in the mother's back. They come out of the skin when they are about $2\frac{1}{2}$ months old or older.



American Museum of Natural History

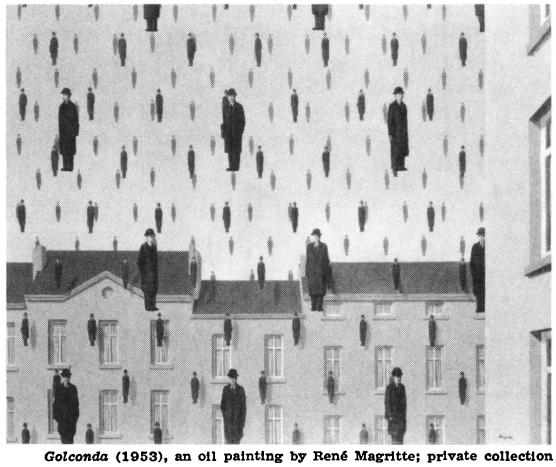
The Back of the Female Surinam Toad provides a living place for young toads until they can take care of themselves.

Scientific Classification. The Surinam toad is in the Surinam toad family, *Pipidae*. It is classified as genus *Pipa*, species *P. pipa*. W. FRANK BLAIR

SURNAME. See NAME, PERSONAL (Beginnings).

SURREALISM is a movement in art and literature. It was founded in Paris in 1924 by the French poet André Breton. Like dadaism, from which it arose, surrealism uses art as a weapon against the evils and restrictions that surrealists see in society. Unlike dadaism, however, surrealism tries to reveal a new and higher reality than that of daily life. *Surrealism* is an invented word meaning *super realism*.

The surrealists claim to create forms and images not primarily by reason, but by unthinking impulse and blind feeling—or even by accident. Using these methods, the surrealists declare that a magical world—more beautiful than the real one—can be created in art and literature. Much of the beauty sought by surrealism



Golconda (1953), an oil painting by René Magritte; private collection

Surrealistic Painting combines recognizable forms in unnatural ways in an attempt to produce a feeling of mystery.

is violent and cruel. In this way, the surrealists try to shock the viewer or reader and show him what they consider the deeper and truer part of man's nature. The movement is not so strong as it once was, but it still influences artists and writers throughout the world.

Some surrealists, such as André Masson, have painted pictures using free, doodlelike brushstrokes. Others, including René Magritte and Salvador Dali, use carefully drawn realistic forms to create dreamlike images. Max Ernst often combines both styles of painting. In many of Ernst's pictures, strange creatures seem to emerge from patterns of paint spread haphazardly over the canvas. MARCEL FRANCISCONO

See also DADAISM; BRETON, ANDRÉ; DALI, SALVADOR; ERNST, MAX; FRENCH LITERATURE (Surrealism); PAINTING (Surrealism; pictures).

SURREY. See ENGLAND (political map).

SURREY, EARL OF (1517?-1547), HENRY HOWARD, is usually linked in literary history with Sir Thomas Wyatt. They are considered the two greatest English poets at the dawn of the English Renaissance. Surrey, a

courtier and military commander during the reign of Henry VIII, was the originator of blank verse. He and Wyatt introduced the Italian sonnet form into English poetry. Their poems were first published in *The Book of Songs and Sonnets* (1557). This book is usually called *Tottel's Miscellany*. Surrey was beheaded in 1547 on a charge of high treason. PAUL M. KENDALL

SURTAX. See INCOME TAX.

SURTSEY. See VOLCANO (Famous Volcanic Eruptions).

SURVEYING is the technique of measuring to determine the position of points, or of marking out points and boundaries. The points may be on, beneath, or even above the earth's surface. Surveying is as old as civilization. It began in Egypt. Every year, after the Nile River overflowed its banks and washed out farm boundaries, the Egyptians fixed new boundaries by surveying.

Types of Surveys depend upon their uses.

The *land survey* is the type with which people are most familiar. It is used to fix boundaries and to find the areas of plots of ground. In Canada and the Western United States, the boundaries and divisions of public lands have been fixed by government surveyors. A *plane survey* is used on small plots of ground only, since it does not take into consideration the curvature of the earth's surface. A *geodetic survey* allows for curvature and is used to find large areas or long boundaries.

The *topographical survey* includes the measuring of altitudes of elevations and depressions for the purpose of making maps. The U.S. Geological Survey makes and publishes topographic maps of the United States.

Engineering surveys are made where buildings, bridges, roads, canals, and other man-made objects are to be built. *Underground surveys* determine where pipes are to be laid or tunnels dug. *Nautical*, or *hydrographic*, *surveys* map out the bed of a river or lake or ocean. By studying riverbeds, man can learn to control the flow of water and erosion. Both have greatly helped navigation.

Aerial survey, or *photogrammetry*, determines distances on the ground by means of photographs taken from airplanes. These photographs include a great amount of detail that a ground observer either cannot or does not get. Aerial surveying is almost always used for topographic mapping of large areas.

Surveying Tools. The most important of all tools used by the surveyor is the *transit*. This is a small telescope set up on a *tripod* (three-legged stand). To it are attached both horizontal and vertical arcs, used to measure horizontal and vertical angles. It has vernier scales by which the surveyor can read very small fractions of degrees (see VERNIER). Both the tripod and the telescope may be made level with attached *spirit levels*, similar to those used by carpenters. A *plumb bob* (weight) hangs from the tripod's center and points to the exact spot where the surveying instrument is set up.

Besides measuring and setting out angles, the transit judges distances. With the use of the telescope and levels, the surveyor can also determine where ground must be leveled. Some transits have compasses attached. A surveyor can plot a north-south line simply by pointing his telescope directly north and having a helper place a stake in line with the vertical hair which crosses the center of the telescope.

Surveyors use a long *steel tape* to measure or set out distances. Most steel tapes are 50, 100, or 200 feet long, or 15, 30, or 50 meters long. Surveyors use an *invar tape* when making extremely precise measurements. Invar tapes, made of nickel and steel, are less affected by changes in temperature than are steel tapes.

The Basis of Surveying is geometry. Angles and triangles play a very important part in the work. A surveyor must have a thorough knowledge of geometry and trigonometry. He must be able to use delicate instruments with precision and accuracy. For a diagram of how surveying works, see PARALLAX.

Careers in Surveying. Modern surveying is closely connected with the various branches of engineering, especially civil engineering. Surveyors find work to do whenever there are roads, dams, and bridges to be built. They determine the boundaries of the property held by individuals, as well as the boundaries of various political divisions. B. AUSTIN BARRY

Related Articles in WORLD BOOK include:

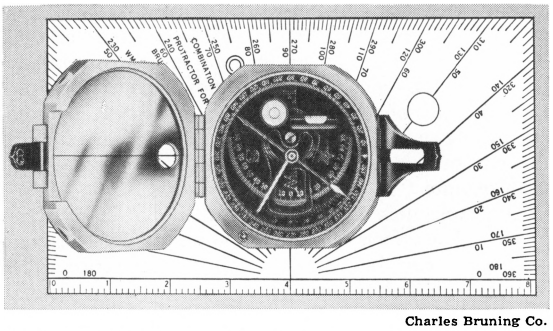
Alidade	Geodesy	Plane Table
Base Line	Level	Public Lands
Bench Mark	National Ocean Survey	Surveyor's Compass
Chain	Photogrammetry	Theodolite
Chart		Transit

SURVEYOR. See SPACE TRAVEL (picture: Surveyor).

SURVEYOR'S COMPASS is an instrument used for determining magnetic directions. Although engineer's transits often have a compass, the true surveyor's compass has no telescopic sighting device. Pointings are made by open sights similar to rifle sights.

The magnetic needle is the essential part of a surveyor's compass. This piece of hard steel, that is magnetized and balanced, swings in a plane parallel to the horizon. The needle generally pivots on a jeweled bearing to reduce swinging friction to a minimum. The ends of the needle, sharpened to knifelike edges, pass near ruled degree markings. At present, engineers use the surveyor's compass only in surveying land of little value, since this instrument is inferior in precision to the engineer's transit. See TRANSIT.

A surveyor must allow for the errors of a compass. For example, the balance of the needle on its pivot can be for only one zone of magnetic dip. Lines of magnetic force come up out of the earth as well as from the magnetic poles. Therefore, a free-moving needle always will dip as well as swing. Also, the lines of magnetic force from the earth are not constant in direction. They vary from day to day and even from hour to hour. Sunspots may cause this variation. The magnetic quality of



Charles Bruning Co.

A Surveyor's Compass has a mirror on the inside lid which makes it possible to read the compass face while sighting objects.

nearby rocks also will affect the compass needle. The man at the compass can carry no iron. All metal likely to disturb the magnetic needle, such as knives and steel-rimmed glasses, must be left behind. B. Austin Barry

See also Compass.

SURVEYOR'S MEASURE. See Weights and Measures (Length and Distance; Surface or Area).

SURVIVAL OF THE FITTEST. See Natural Selection.

SUSA, *SOO zuh*, or Shush, was once the capital of the ancient Kingdom of Elam and the Persian Empire. The partly uncovered ruins of this city lie in the province of Khuzistan, in southwestern Iran. Susa appears several times in the Bible, where it is called *Shushan*. The Old Testament story of Esther took place in Susa. The tomb of Daniel is said to be in Susa. Archaeologists found the famous *Code of Hammurabi*, a collection of Babylonian laws, in the ruins of Susa in 1901. Susa flourished until about 640 B.C., when the Assyrians plundered it. Darius I built palaces in the city in the early 500's B.C., and made it one of the capitals of the Persian Empire. Susa declined after Alexander the Great conquered it in the late 300's B.C. Richard Nelson Frye

See also Esther; Daniel; Hammurabi.

SUSLOV, *SUS loff*, **MIKHAIL ANDREYEVICH** (1902-), is a leading Russian Communist Party official. He has been a member of the Politburo, the most powerful policy-making body of the party, since 1955, and the party's Central Committee since 1947. Suslov served as Russian political director in Lithuania from 1944 to 1946. In 1949 and 1950, he was editor of the party's newspaper, *Pravda* (Truth). Suslov was born in Skakhovskoe, Russia. Walter C. Clemens, Jr.

SUSPENDED ANIMATION describes a condition in which the vital functions of the body are stopped for brief periods. Suspended animation occurs in drowning. Rescuers find that the drowned person's breathing has stopped. They cannot feel his pulse nor hear his heartbeat. The person will die unless the rescuers start artificial respiration (see Artificial Respiration).

Suspended animation also describes conditions in which a person cannot move and seems to be in a deathlike trance. This occurs in some types of mental illness and is called catalepsy (see Catalepsy). Fakirs can produce this condition in themselves (see Fakir).

See also Cryobiology; Trance.

SUSPENSION is a mixture of solid particles in a gas or a liquid. Smoke particles form a suspension in air, and muddy water is a suspension of tiny dirt particles in water. A suspension differs from a *solution*, another kind of mixture. The substances in a suspension can usually be separated by mechanical methods, such as filtration. But the substances in a solution must be separated chemically or by distillation. A mixture of two liquids that do not dissolve in each other, such as oil and water, is an *emulsion*.

The molecules of liquids and gases are in constant motion. The effects of this motion on the particles in a suspension can be seen through a microscope. The moving molecules bump into the larger suspended particles, making the larger particles move in a fast, jiggling manner. This motion of suspended particles was first described in 1827 by Scottish physicist Robert Brown. The motion became known as *Brownian motion*.

Eventually, gravity makes the particles in a suspension *settle* (separate from the surrounding substance). The rate of settling depends partly on the size of the particles. Large particles settle faster than small particles. Road dust settles rapidly after being suspended briefly in air by a passing automobile. But smaller smoke particles may remain in the air until rain washes them down to the ground. Extremely small particles may remain suspended indefinitely. For example, the tiny fat particles in homogenized milk remain suspended, instead of rising and forming a layer of cream. The only motion of these suspended fat particles is their Brownian motion. John P. Fackler, Jr.

SUSPENSION BRIDGE. See Bridge.

SUSQUEHANNA RIVER, *sus kwuh HAN uh*, is a swift but shallow waterway flowing through one of the most important industrial regions in the eastern United States. The river rises at Otsego Lake in central New York state. It flows southward across Pennsylvania into Maryland, where it empties into Chesapeake Bay at Havre de Grace. For location, see Middle Atlantic States (map). The river is 444 miles (715 kilometers) long. The river's swift current, rock obstructions, and shallow bed discourage shipping. But the Susquehanna has the greatest water-power potential of the rivers in the northeastern United States. E. Willard Miller

SUSQUEHANNA UNIVERSITY. See Universities and Colleges (table).

SUSSEX. See England (political map).

SUSSEX, New Brunswick (pop. 3,942), is the center of a rich farming district about halfway between Saint John and Moncton in Canada (see New Brunswick [political map]). Gently sloping hills, fertile valleys, and many small streams make the Sussex region excellent for cattle grazing. Sussex is known for its production of milk, butter, and soft drinks. The region has a variety of small industries, the most important of which are lumbering and the manufacture of ice cream. Once known as Sussex Vale, it was founded by United Empire Loyalists in 1783. Sussex has a mayor-council form of government. W. S. MacNutt

SUSSEX SPANIEL originated in England, and gets its name from the county of Sussex, in southern England.

The Sussex Spaniel

WORLD BOOK photo by C. F. Williams

It is a strong stocky dog with short legs. The Sussex weighs from 35 to 45 pounds (16 to 20 kilograms). Its coat is usually a golden liver color. The Sussex has never been popular in the U.S. MAXWELL RIDDLE

SUTHERLAND, EARL W., JR. See NOBEL PRIZES (table: Nobel Prizes for Physiology and Medicine—1971).

SUTHERLAND, GEORGE (1862-1942), served as an associate justice of the Supreme Court of the United States from 1922 to 1938. During the dispute over the validity of New Deal legislation, he voted regularly to hold the measures unconstitutional. In the famous "Scottsboro" case of 1932, his opinion advanced the constitutional rights of persons accused of crime. Sutherland served as a Republican congressman from Utah, and as a United States senator. He was born in Buckinghamshire, England. JERRE S. WILLIAMS

SUTHERLAND, JOAN (1926-), an Australian operatic soprano, won acclaim for her brilliant vocal technique. Her voice has a depth and richness not usually associated with the ornate style of her operatic roles. She ranks among the greatest singers of her time for her range, flexibility, and ease of singing in rapid passages of pinpoint precision. She enjoyed great success in London and New York City. Italian opera audiences nicknamed her "La Stupenda," *the stupendous one.*

Wide World

Joan Sutherland

Joan Sutherland was born in Sydney, and received her early training there. She moved to London in 1951 and made her operatic debut at the Covent Garden Opera in the title role in *Lucia di Lammermoor* in 1959. She first appeared in the United States in 1961. MAX DE SCHAUENSEE

SUTHERLAND FALLS is the fifth highest mountain waterfall in the world. It lies 16 miles (26 kilometers) from the head of Milford Sound, in the Southern Alps of South Island, New Zealand. Its waters plunge down a mountainside in three leaps from a height of 1,904 feet (580 meters). The first leap is 815 feet (248 meters); the second, 751 feet (229 meters); and the third, 338 feet (103 meters). Water from melting glaciers forms the falls. The waters eventually flow into Milford Sound. See also WATERFALL (picture chart). JOHN BELL CONDLIFFE

SUTLEJ RIVER, *SUT lej,* is the most easterly of the five waterways of Punjab Province, Pakistan. It ranks as the largest branch of the Indus, the chief river of Pakistan. The Sutlej rises in the plateau of Tibet, nearly 3 miles (5 kilometers) above sea level. The river winds through the Himalaya mountains and crosses northwestern India. Then it flows southwest through Pakistan's Punjab Province. It joins the Indus in the east-central part of Pakistan. The Sutlej is about 950 miles (1,530 kilometers) long. It is a major source of water for the dry Punjab plains. One of the world's highest dams, the Bhākra Dam, rises 740 feet (226 meters) above the river near Bhākra, India. J. E. SPENCER

SUTTEE, *suh TEE,* is a Hindu custom once practiced in India. Its name comes from the Sanskrit word *sati,* which means *faithful wife.* By the custom of suttee, a widow allows herself to be burned to death beside her husband's body on the funeral pyre. The pyre is a pile of material that burns easily. No one knows how the custom began. An ancient book states that a widow should lie by her husband's body on the pyre. A few widows, especially wives of kings, refused to leave the pyre and burned to death. In 1829, the British rulers of India made suttee illegal. WILFRID D. HAMBLY

SUTTER, JOHN AUGUSTUS. See CALIFORNIA (The Gold Rush); SACRAMENTO.

SUTURE, *SOO tyoor,* is the line formed where bones are joined in an immovable joint, as in the skull. It is also the sewing-up of an *incision* (opening) in surgery. Doctors call the material used for sewing an incision a suture, too. This material is made of catgut, fine silk, linen, wire, or nylon. See also LIGATURE.

SUVA (pop. 60,000) is the capital and largest city of Fiji, a country made up of about 350 islands in the South Pacific Ocean. The city lies on the southeastern coast of Viti Levu, the largest of Fiji's islands. For location, see FIJI (map). Suva is Fiji's chief seaport and commercial center. Ships stop at the city to load *copra* (dried coconut meat) and tropical fruit. Many tourist ships also stop there. Factories in Suva make coconut oil and soap. The city's Fiji Museum stands inside the Botanical Gardens. The University of the South Pacific is also in Suva. See also FIJI (picture). STUART INDER

SUWANNEE RIVER winds for about 190 miles (306 kilometers) through southern Georgia and northern Florida and empties into the Gulf of Mexico. Stephen Foster, who called the river *Swanee,* made it famous with his song, "Old Folks at Home."

The river rises south of Waycross, Ga. It helps drain the Okefenokee Swamp, and flows in a winding course past many small communities. Only very small boats can navigate the Suwannee. In northern Florida, the river forms parts of the boundaries of eight counties. It reaches the Gulf of Mexico at Suwannee Sound, where Hog Island divides the river into two distributaries (see FLORIDA [physical map]). JOHN H. GARLAND

SUZERAIN, *SOO zuh rayn,* was a feudal lord in medieval times. Today, the term refers to a state which has political control, or *suzerainty,* over another state.

SVALBARD, *SVAHL bahr,* is a group of islands in the Arctic Ocean, about midway between Norway and the North Pole. The islands belong to Norway, and Svalbard is their Norwegian name. They are sometimes called by their German name, Spitsbergen. Svalbard has five large islands and many smaller ones. The main islands are Spitsbergen, North East Land, Edge Island, Barents Island, and Prince Charles Foreland. Svalbard covers 23,958 square miles (62,051 square kilometers). It is about 700 miles (1,100 kilometers) from the North Pole (see ARCTIC OCEAN [color map]). Svalbard has no permanent residents, but boats stop there each year when the harbors are free of ice. Svalbard has been the base for many Arctic explorations.

Norse Vikings probably visited the islands. Early Norwegian stories mention Svalbard. In the Middle Ages, the Norwegian kings claimed Svalbard. A Dutch expedition under Willem Barents rediscovered the islands in 1596 (see BARENTS, WILLEM). Henry Hudson saw them in 1607. No one settled on the islands until

after the Norwegians began mining coal there in the 1890's. In 1920, other countries formally recognized Norway's claim to the islands. OSCAR SVARLIEN

SVEDBERG, *SVAY BAR'y*, **THEODOR** (1884-1971), a Swedish chemist, became famous for developing the ultracentrifuge. This apparatus can spin materials so fast that they have 500,000 times the force of gravity acting upon them. It made it possible to determine the molecular weights of proteins and aided the study of the colloidal state. Svedberg is also known for preparing colloidal solutions of metals using an electric arc. He received the 1926 Nobel prize in chemistry. Svedberg was born in Valbo, near Gävle, Sweden. K. L. KAUFMAN

SVENGALI. See DU MAURIER (George).

SVERDLOVSK, *svehrd LAWFSK* (pop. 1,048,000), is a trading and manufacturing center in the Ural Mountains of Russia. The city is located on the eastern slope of the Ural Mountains, about 1,200 miles (1,930 kilometers) northeast of Moscow (see RUSSIA [political map]). Sverdlovsk is a railroad center and the largest city in the Urals. It has a machine-building industry.

After the Russian Revolution, the Bolsheviks murdered Czar Nicholas II and his family on July 16, 1918, at Sverdlovsk, where they were imprisoned. The city was then called *Ekaterinburg*. THEODORE SHABAD

SWAHILI, *swah HEE lee*, are an African people of mixed Bantu and Arab ancestry. The Swahili live along the east coast of Africa, from Somalia to Mozambique. The word *Swahili* means *coast people*. The Swahili language is used throughout East Africa for business and communication among various tribes. It serves as the official language of Kenya and Tanzania. All the Swahili are Moslems.

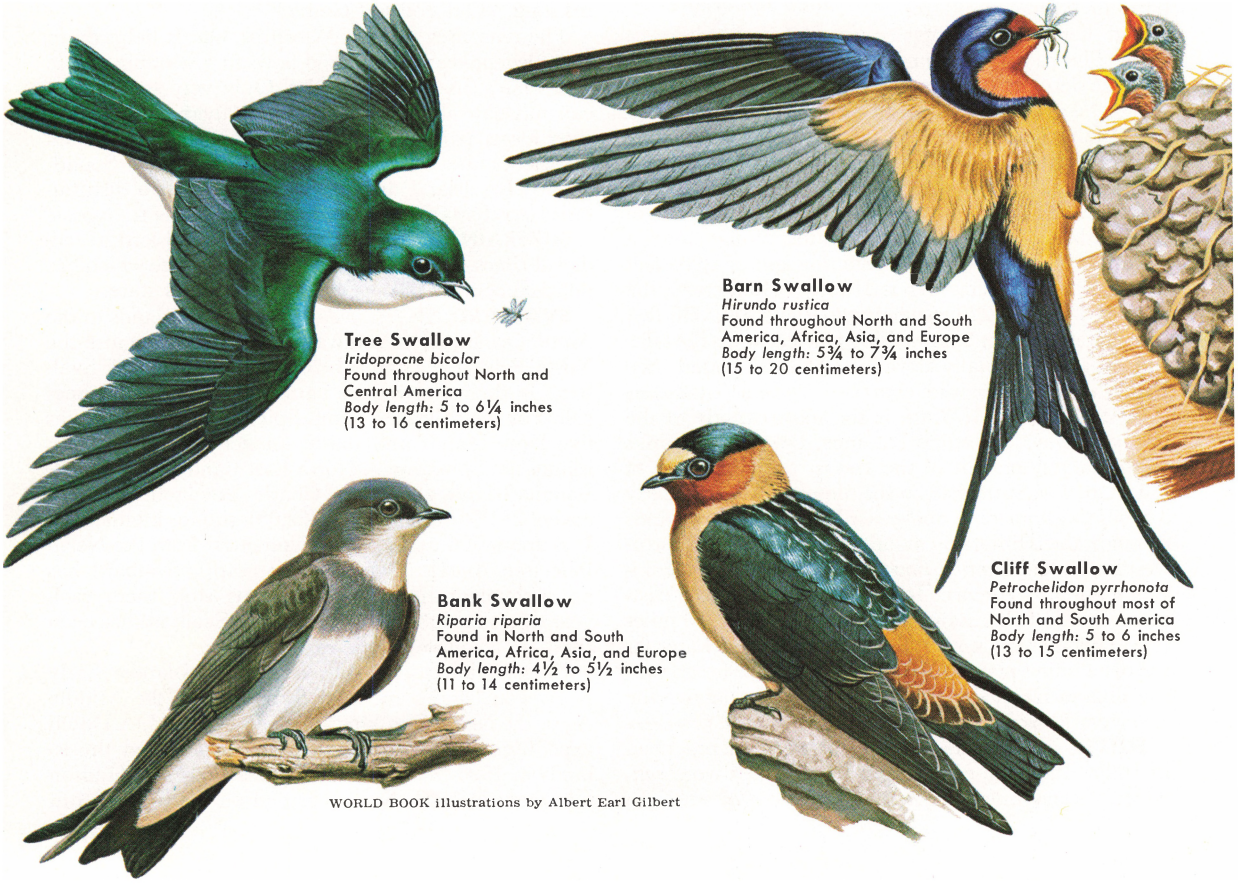
Historians believe that Moslem Arab traders began to settle in East African coastal villages about the time of Christ. The native and Arab cultures gradually mixed and developed into the Swahili civilization. From about 1200 to 1500, many Swahili city-states became thriving commercial centers. They included Kilwa, Lamu, Malindi, Mombasa, and Zanzibar. The Swahili traded gold, ivory, and slaves from the African interior for goods from China, India, and Persia.

During the 1500's and 1600's, the Portuguese looted many Swahili cities and seriously damaged the Swahili trade. Omani Arabs later replaced the Portuguese as rulers of the Swahili. JOHN MIDDLETON

SWAINS ISLAND lies in the South Pacific Ocean, 200 miles (322 kilometers) north of Samoa (see PACIFIC ISLANDS [map]). The 800-acre (324-hectare) island is composed of a ring of sand and coral surrounding a brackish lagoon. Coconut palms cover the island. The islanders export copra. The island has about 75 people. It was placed under the jurisdiction of American Samoa in 1925. It had been part of the Tokelau Islands. See also AMERICAN SAMOA. EDWIN H. BRYAN, JR.

SWALLOW is a small, graceful bird. It has long, powerful wings, and small, weak feet suited only for perching. It has a large mouth adapted to catching flying insects, which make up nearly all its food. It eats many mosquitoes.

Swallows are found in all parts of the world. Most of them fly long distances to avoid cold or to find a



food supply. So far as is known, they *migrate* (travel) by day. They fly together in large numbers, and spend the nights in woods or marshes. Some swallows nest in pairs, and some in colonies. Some make their homes in holes in banks or trees. Others build rough nests of clay or mud on beams of bridges, on rafters in barns, or under the eaves. Several kinds of swallows have changed their nesting habits through their contact with man.

Female swallows lay 3 to 9 eggs which are pure white, or white spotted with brown. Swallows twitter rather than sing. Some species of swallow have distinctive forked tails, which are called "swallowtails."

The swallows of North America include the *barn swallow*. The barn swallow has a steel-blue back, chestnut-colored breast, and deeply forked tail. Some of these swallows travel as much as 10,000 miles (16,000 kilometers) in yearly migrations. The *cliff swallow* has a square tail and a light-brown patch on its rump. The *tree swallow* often nests in birdhouses. The *bank swallow*, or *sand martin*, is the smallest of the family. The *purple martin* also is a member of the swallow family.

Scientific Classification. The swallows belong to the swallow family, *Hirundinidae*. The barn swallow is genus *Hirundo*, species *H. rustica;* the cliff swallow, *Petrochelidon pyrrohonta;* the tree swallow, *Iridoprocne bicolor;* the bank swallow, *Riparia riparia.* ARTHUR A. ALLEN

See also BIRD (pictures: Bird Nests, Wings for Maneuvering); MARTIN; SAN JUAN CAPISTRANO.

SWALLOWING is the process of taking food and saliva from the mouth to the stomach through a tube called the *esophagus* (see ESOPHAGUS). A mucous membrane lines the esophagus so that food can slide down without sticking to the sides. After a person chews food, he swallows it. The muscles of the walls of the esophagus perform the swallowing process. These muscles *contract* (shorten). The muscles wave or ripple, normally in a downward direction toward the stomach. This movement is called *peristalsis*. When the muscles in the esophagus cause abnormal wavelike movements upward toward the mouth, vomiting may take place. When the food reaches the lower end of the esophagus, a ringlike muscle opens and allows the food to pass into the stomach.

The presence of certain diseases, or of nervousness, such as stage fright, may cause difficulty in swallowing. Growths, such as tumors or cancers on the esophagus, may also cause the difficulty. In these cases, the esophagus may close. Then food is prevented from entering the stomach. WILLIAM C. BEAVER

See also ALIMENTARY CANAL.

SWAMMERDAM, *SWAHM ur dahm*, **JAN** (1637-1680), was a Dutch anatomist and zoologist. He pioneered in the study of minute anatomy, especially the anatomy of insects. He used specially designed scissors, and knives so tiny that they had to be sharpened under a microscope. His observations on the life histories of bees and mayflies are classics, and his work in classifying formed the basis of entomology, the study of insects. A prodigious worker, Swammerdam also made important early observations on the physiology of nerves and muscles. Swammerdam was born in Amsterdam. He studied medicine, and soon began anatomical studies, which he pursued with such intensity that he ruined his health. Much of his most important work was not published until more than 50 years after his death. But his *Historia Insectorum*, a study of the metamorphoses of insects, the effects on animals of the deprivation of blood, and similar subjects was published in 1669. *Bijbel der Nature*, a report on his observations of red blood corpuscles in animals, was published in 1737. ROGERS MCVAUGH

SWAMP is land which is more or less completely soaked with water. It is always damp and muddy. A swamp is usually on low ground, near the shore of some large body of water, but there are some swamps on hills. Sometimes the soil on a hill drains poorly, while water from springs keeps it swampy. Swamps are also formed in lake basins which have become filled with plant life. This kind of swamp is given an Indian name, *muskeg*. A swamp is much like a peat bog, but the swamp's lower layers of soil are not acid like those of a peat bog. Wet or inundated swamps are termed *marshes*. Mosquitoes often breed in these. In England, particularly near Cambridge and Ely, some marshes are called *fens*. One of the largest swamps in the United States is Okefenokee in Georgia. ELDRED D. WILSON

See also DISMAL SWAMP; EVERGLADES; MARSH; OKEFENOKEE SWAMP; PONTINE MARSHES.

SWAMP FOX. See MARION, FRANCIS.

SWAMP HICKORY. See BITTERNUT.

SWAMP ROSE MALLOW. See HIBISCUS.

SWAN is a stately water bird closely related to geese and ducks. The swan has snowy white feathers and a long graceful neck. Many poets and composers have written about the swan, and it often appears in legends, as in Richard Wagner's opera, *Lohengrin*. Fairy tales sometimes feature the swan, as in Hans Christian Andersen's "The Wild Swans."

The swan group consists of seven *species* (kinds)

Kenneth W. Fink, NAS

The Whistling Swan is a graceful swimmer. Every fall, flocks of these birds migrate from the Arctic Ocean to coastal bays of the United States, where they spend the winter.

that live in various parts of the world. They fly in V-shaped flocks, and utter loud, trumpetlike notes while flying. Swans feed on worms, shellfish, and the seeds and roots of water plants. The birds dip their long, curving necks far into the water in search of food.

The *whistling swan* nests around the Arctic Ocean and the Hudson Bay region. It has decreased sharply in number. In winter, it flies as far south as the Carolinas. Between October and April, flocks of whistling swans fly southward. Observers report they can fly at speeds of 40 to 50 mph (64 to 80 kph). As they fly, the swans fill the air with a wide range of whistling sounds. Whistling swans make their nests out of water plants and line them with down from their bodies. Their nests sometimes stand 2 feet (61 centimeters) high and measure 6 feet (1.8 meters) across. The female lays five to seven white eggs in June. The young, called *cygnets*, are covered with grayish-brown down at first. They become snow-white by the end of a year. The male swan is called a *cob*, and the female a *pen*.

The whistling swan grows a little less than 5 feet (1.5 meters) long. It is white except for a yellow spot between the nostrils and eyes. The legs, feet, and bill are black. The *trumpeter swan*, once almost extinct, resembles the whistling swan. It weighs up to 40 pounds (18 kilograms), making it the heaviest flying bird in North America. Its call sounds clear and shrill. The *black-necked swan* is a waterfowl that lives in South America.

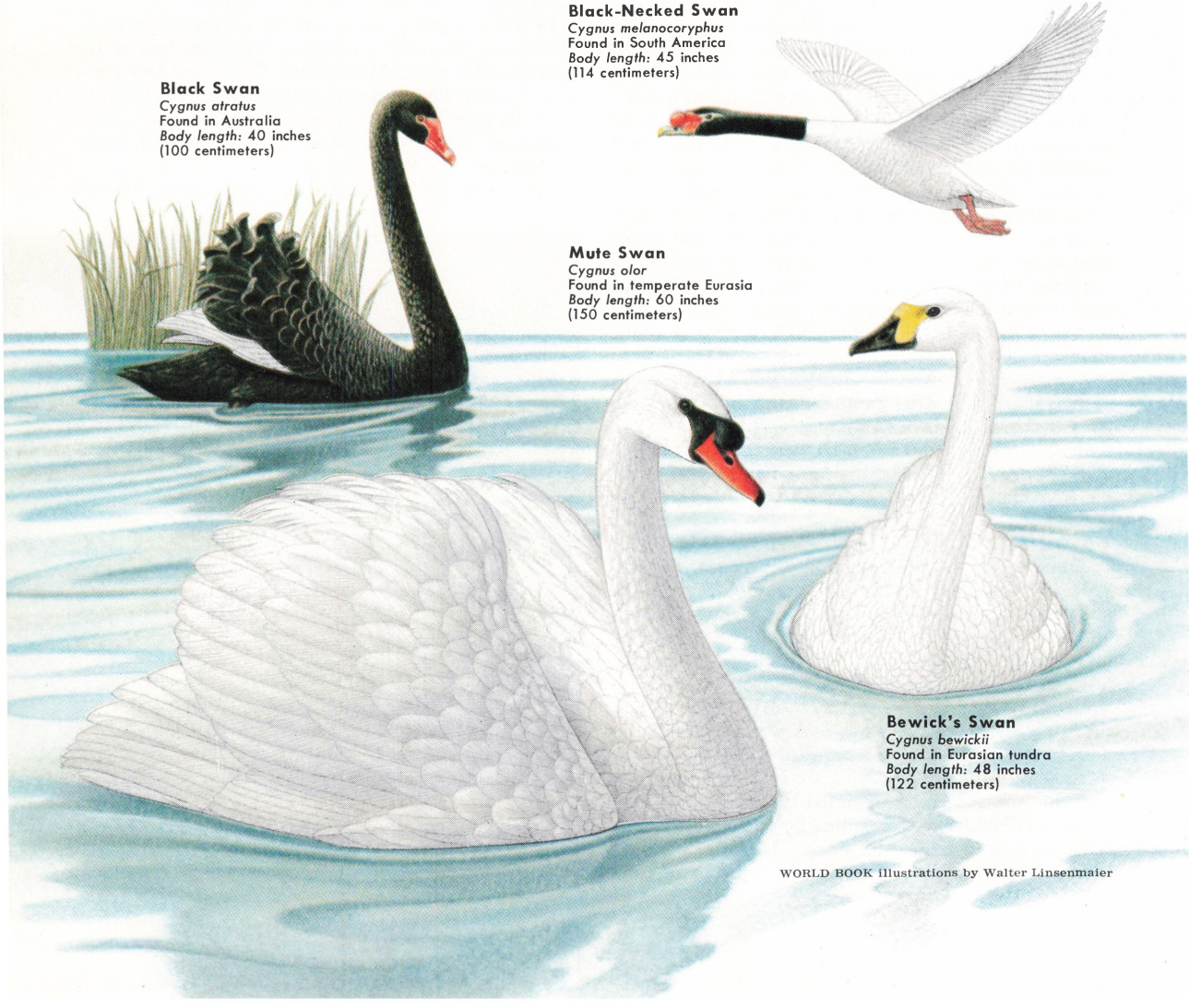
Swans of the Eastern Hemisphere include the *European whistling swan*, the *mute swan*, and *Bewick's swan*, which is a smaller bird. The mute swan, considered a royal bird in England since 1462, can be seen in zoos, parks, and estates there. It is said that this swan never uses its voice in captivity. The *black swan*, marked by a scarlet bill banded with white, lives in Australia.

Scientific Classification. Swans belong to the swan, goose, and duck family, *Anatidae*. The mute swan is genus *Cygnus*, species *C. olor*. The black swan of Australia is *C. atratus*. The whistling swan is *Olor columbianus;* the trumpeter swan is *O. buccinator*. RODOLPHE MEYER DE SCHAUENSEE

See also BIRD (color picture: Birds of Other Lands).

SWANSCOMBE MAN was a type of prehistoric man who lived about 275,000 years ago. The only evidence of his existence is three pieces of a skull. They were

The Swan is one of the largest birds, but it swims and flies gracefully. Its beauty has inspired composers, painters, and writers. Four of the seven species of swans are shown below.



found at Swanscombe, near London, in the gravel of the River Thames. The first piece was found in 1935. Swanscombe man lived in forested river valleys that provided deer, elephants, hippopotamuses, and rhinoceroses for hunting.

Another skull, more complete than that of Swanscombe man but of about the same age, had been discovered in 1933 at Steinheim, in southern Germany. Most scientists believe the Swanscombe and Steinheim fossils represent early forms of modern man—*Homo sapiens* (wise man). The Swanscombe and Steinheim discoveries suggest that early forms of Homo sapiens replaced Heidelberg man in Europe (see HEIDELBERG MAN). The Swanscombe and Steinheim skulls weigh less, and the brain case is a little larger, than those of Heidelberg man.

KARL W. BUTZER

SWANSEA, *SWAHN see* (pop. 171,520), is the second largest city in Wales. It lies about 45 miles (72 kilometers) west of Cardiff on Swansea Bay. For location, see GREAT BRITAIN (political map).

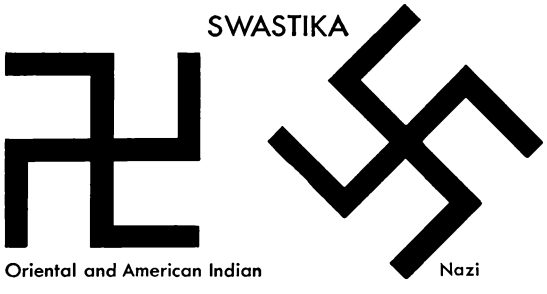
The city was founded in the 1000's. It became important in the 1800's, after the development of the hard-coal trade and the smelting industry. The use of tin cans for preserving fruits and vegetables brought prosperity to the city. Swansea became the chief British center for the shipping of tin plate. It was once called the "tin plate center of the world." Other industries in Swansea include the refining of nickel, zinc, and petroleum. The city has modern docks which cover 281 acres (114 hectares).

DAVID WILLIAMS

SWARM. See BEE (Swarming; picture).

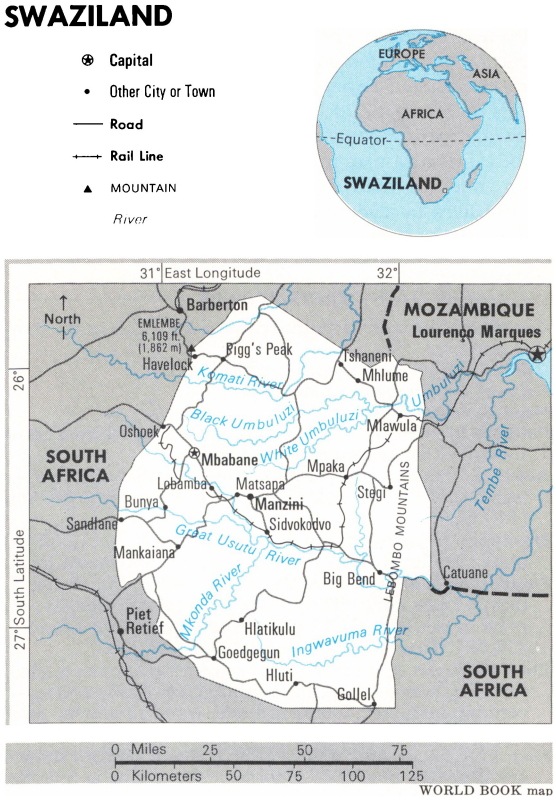
SWARTHMORE COLLEGE. See UNIVERSITIES AND COLLEGES (table).

SWASTIKA, *SWAHS tih kuh*, is an ancient symbol often used as an ornament or a religious sign. The swastika is in the form of a cross with the ends of the arms bent at right angles in a given direction, usually clockwise. The swastika has been found on Byzantine buildings, Buddhist inscriptions, Celtic monuments, and Greek coins.



Swastikas were widely used symbols among the Indians of North America and South America. The clockwise swastika was adopted in 1920 as the symbol of the National Socialist Party of Germany. As such it came to be one of the most hated symbols in the history of man. It came to stand for all the evil associated with the Nazis as they gained control of Europe before and during World War II. After the Allies defeated Germany in 1945, they banned the display of the swastika emblem.

JOSEPH WARD SWAIN



SWAZILAND, *SWAH zee land*, is a beautiful little country in southern Africa. It is surrounded by the Republic of South Africa on three sides and by Mozambique on the east. Swaziland is about as big as Hawaii, but it has only about three-fifths as many people.

Swaziland has rich mineral deposits, large forests, and good farm and ranch land. But most of the mines, processing plants, and profitable farms are owned by Europeans. Most of the *Swazi* (black Africans) who live there are peasant farmers.

Swaziland was formerly a British protectorate. It became independent in 1968 as the KINGDOM OF SWAZILAND. Mbabane, with a population of about 18,000, is the administrative capital and largest town (see MBABANE).

Government. Swaziland is a monarchy. The *Ngwenyama* (hereditary leader) rules as king, with the assistance of a cabinet. The *Ndlovukazi* (queen mother) is in charge of national rituals. The Swazi National Council, an advisory group, meets at Lobamba, the traditional capital. All Swazi men are considered council members.

People. About 9 out of 10 persons in Swaziland are black Africans called Swazi. The Swazi are proud, handsome, courteous people. Most of them farm and raise livestock. Some live in towns and work in factories, offices, and shops. They speak *siSwati*, a Bantu language.

Hilda Kuper, the contributor of this article, is Professor of Anthropology at the University of California at Los Angeles and the author of An African Aristocracy: Rank Among the Swazi *and* The Swazi: A South African Kingdom.

SWAZILAND

Swazi farmers prize their cattle and respect a man with a large herd. They rarely kill cattle for food, but some are sold for cash or sacrificed at religious ceremonies. When a Swazi man marries, his family gives his wife's family cattle to legalize her status as his wife.

Swazi men may have more than one wife. The ideal family includes a man, his wives, his unmarried children, and his married sons and their families. Each family lives in a separate homestead. For hundreds of years, the homesteads consisted of circular huts built around a cattle pen. Today, there are a variety of homestead plans, and many Swazi live in Western-style houses. In homesteads with more than one wife, each wife has her own living quarters. She also has a garden plot where she grows beans, corn, gourds, millet, peas, and other crops. The men and boys tend the cattle.

Traditional Swazi clothing is made of animal skins, leather, or brightly colored cloth. Swazi also wear beautiful beaded ornaments.

Each Swazi man belongs to an *age group* organized by the Ngwenyama. All the men in a particular group are about the same age. Different age groups have special parts in Swazi ceremonies. Four out of five adults in Swaziland cannot read or write. But about 60,000 children were attending school there in the early 1970's.

More than half the Swazi belong to various Christian churches. Most of the rest practice a traditional religion based on ancestor worship.

About 8,000 Europeans and *Eurafricans* (people of mixed descent) also live in Swaziland. The Europeans own farms, mines, and forests. Many Eurafricans work for the Europeans. Others are farmers and craftsmen.

Land. Mountains up to 4,500 feet (1,370 meters) above sea level rise along Swaziland's western border. Vast pine forests cover much of the land there. Temperatures average 60° F. (16° C), and from 45 to 75 inches (114 to 191 centimeters) of rain falls each year. Rolling, grassy midlands lie east of the mountains. More people live in this region than in any other part of the country. Temperatures average 66° F. (19° C) and from 30 to 45 inches (76 to 114 centimeters) of rain falls there each year. Farther east, the land levels off into a low plain covered with bushes and grass. Temperatures average 72° F. (22° C) and only about 20 inches (51 centimeters) of rain falls per year. The high, narrow Lebombo Mountains rise along the eastern border.

Swaziland is one of the best-watered areas in southern Africa. Four main rivers flow eastward across the country. They are the Ingwavuma, Komati, Umbuluzi,

FACTS IN BRIEF

Capitals: Mbabane (administrative) and Lobamba (traditional).
Official Languages: English and siSwati.
Form of Government: Monarchy.
Head of State: King.
Political Divisions: Four districts, each headed by a commissioner or assistant commissioner.
Area: 6,704 sq. mi. (17,363 km²). *Greatest Distances*—north-south, 120 mi. (193 km); east-west, 90 mi. (140 km).
Elevation: *Highest*—Mount Emlembe, 6,109 ft. (1,862 m) above sea level. *Lowest*—70 ft. (21 m) above sea level.
Population: *Estimated 1976 Population*—481,000; distribution, 94 per cent rural, 6 per cent urban; density, 69 persons per sq. mi. (27 persons per km²). *1966 Census*—374,697. *Estimated 1981 Population*—547,000.
Chief Products: *Agriculture*—corn, sugar cane, cotton, rice, tobacco, citrus fruits, hides and skins. *Manufacturing*—cement, fertilizer, food products, wood products. *Mining*—asbestos, iron ore.
Flag: Five horizontal stripes. The top and bottom stripes are blue (for peace). The wide center stripe is red (for past battles) with a black and white shield, spears, and staff. Between the blue and red stripes are yellow stripes (for natural resources). See FLAG (color picture: Flags of Africa).
Money: *Basic Unit*—South African rand. For its value in dollars, see MONEY (table: Values [South Africa]).

David Goldblatt, Pix from Publix

The People of Swaziland wear both traditional and European clothing. These Swazis are lined up to vote in Manzini, a leading commercial center.

and Great Usutu. The rivers supply water to irrigate crops and to run hydroelectric power plants.

Economy. Rich agricultural and mineral resources have enabled Swaziland to develop a varied economy. Swaziland is one of the few African countries that exports more goods than it imports.

Europeans own nearly half the land in Swaziland. They raise most of the cash crops, including citrus fruits, cotton, pineapples, rice, sugar cane, and tobacco. They also raise cattle for meat, skins, and hides. Most of the Swazi graze cattle and grow just enough food for their families. But since the late 1960's, an increasing number of Swazi have begun to raise cash crops.

Since the 1940's, Europeans have planted large areas of barren mountainous land in Swaziland with pine and eucalyptus trees. Today, the area has one of the largest man-made forests in Africa. European-owned mills process wood pulp and other forest products there.

Rich mineral deposits lie in the mountains, and about half the nation's income comes from the European-owned mining industry. Asbestos and iron ore are leading exports. Swaziland also has deposits of coal, gold, tin, *barite* (ore used in making barium), and *kaolin* (clay used in making pottery). About 6,000 Swazi work in the gold mines of South Africa.

Since the late 1960's, a number of small manufacturing firms have developed in Swaziland. Factories produce cement, fertilizer, food products, and other goods.

Swaziland has about 1,000 miles (1,600 kilometers) of tar or gravel roads. Winding footpaths run between most homesteads. A railroad connects Mbabane with the port at Lourenço Marques, capital of Mozambique. Air service links Mbabane with South Africa and Lourenço Marques.

History. According to the legends of the Swazi, the tribe once lived near what is now Lourenço Marques. In the late 1700's the Swazi chief Ngwane II led a small band of people over the mountains to what is now southeastern Swaziland. There they found other African tribes. Ngwane II and the chiefs who ruled after him united several of these tribes with the Swazi.

British traders and *Boers* (Dutch farmers from South Africa) first came to Swaziland in the 1830's. In the 1880's, the settlers discovered gold. Hundreds of prospectors rushed into the region. They asked the Swazi chief and his advisers to sign documents granting them rights to mine minerals and to use land for farming and grazing. The Swazi could not read and did not realize that they were giving up control of the land.

In 1894, the British and Boers agreed that the South African Boer Republic would govern Swaziland. But in 1902, the Boers lost a war with the British, and Great Britain took control of Swaziland in 1903. Great Britain ruled Swaziland until the 1960's. In 1967, Swaziland gained control over its internal matters. It received full independence on Sept. 6, 1968. On Sept. 24, 1968, Swaziland became a member of the United Nations.

In 1968, Britain developed a constitution for Swaziland. The constitution established Swaziland as a constitutional monarchy, headed by King Sobhuza II. Many Swazi opposed the constitution because they felt it disregarded certain Swazi traditions. In 1973, King Sobhuza abolished the constitution and took full control of the government. Most of Swaziland's government leaders supported his action. HILDA KUPER

SWEAT. See PERSPIRATION.

SWEAT GLAND. See GLAND; PERSPIRATION.

SWEATSHOP. The word *sweatshop* suggests a place of grinding toil. It is a term for makeshift factories where poverty-stricken people—mostly women and children—work at top speed for 12 or more hours a day in an effort to earn a living wage.

The sweatshop, often called the *sweating system*, began when the factory system developed in the early 1800's. Often, factory buildings were not large enough to house all the workers. So factory owners sublet contracts for part of the work. The other manufacturers then set up makeshift factories in dimly lighted and poorly ventilated buildings. They hired workers for low wages and long hours on a piecework basis.

As early as 1830, Americans began to object to sweatshops. But the problem did not become serious until after 1880, when large numbers of immigrants began to come to America. The owners of sweatshops took advantage of the immigrants' ignorance and poverty to get them to work for low wages. The cigar-making and clothing and needlework industries, and some of the mechanical industries, used the sweating system.

In the 1900's, states began to pass laws prohibiting workers from carrying on work outside the factory in industries where sweatshops were most common. They also passed minimum wage laws which made it impractical for factories to sublet work. Laws limiting the number of hours women could work and abolishing child labor were heavy blows to the sweatshop system. Another factor which hastened its decline was the increased interest which women showed in metalworking and other trades where they could not take work outside the factory. Today, there are few sweatshops left in the world. In most countries, such practices have been made illegal. ROBERT D. PATTON

See also CHILD LABOR; WAGES AND HOURS.

Sweatshops employed people for very low pay. Workers put in long hours in makeshift factories under miserable conditions.

Brown Bros.

WORLD BOOK photo by Tore Johnson

The Rugged Wilderness of northern Sweden has long, cold winters and is thinly populated. Most of the people are lumberjacks or miners.

SWEDEN

SWEDEN is a prosperous industrial nation in northern Europe. The Swedes have developed great industries based on their country's three chief natural resources—timber, iron ore, and water power.

The Swedish standard of living is one of the highest in the world. Sweden has more automobiles, telephones, and radios in relation to its population than any other European nation. Among all the countries of Europe, only tiny Monaco has more television sets in relation to population. Another measure of prosperity is that Swedes spend more money per person on vacations than any other Europeans. About 350,000 Swedish families, or a fifth of the nation's families, have country homes where they can spend weekends and vacations.

Sweden's way of life has often been called the "middle way," because it combines private enterprise with a government that greatly influences the development of the economy. The Swedish government operates one of the most far-reaching social security systems in the world. The government provides free education and largely free medical service. It pays pensions to old people, widows, and orphans. After most Swedes retire, they receive annual pensions of about 60 per cent of their average earnings during their 15 highest paid years. The government also provides health insurance and financial aid for housing.

Sweden is the fourth largest country in Europe, after Russia, France, and Spain. Sweden is a little larger than California, but it is thinly populated and has about two-fifths as many people as that state. Forests cover more than half of Sweden, and only about a tenth of the country is farmland. Sweden is also a land of beautiful lakes, snow-capped mountains, swift rivers, and rocky offshore islands. Stockholm, Sweden's capital and largest city, stands on the coast of the Baltic Sea and includes small offshore islands. Almost a sixth of the people live in Stockholm or its suburbs.

The northern seventh of Sweden lies inside the Arctic Circle in a region called the *Land of the Midnight Sun.*

The contributors of this article are Torsten Henriksson, First Secretary of the Swedish Institute in Stockholm; Johan Henrik Norrbin, a Stockholm biology and geography teacher; István Vukovich, Head of the Rural Development Section of the Swedish International Development Authority; and Carl-Christian Wallén, Chief, Special Environmental Applications Division, World Meteorological Organization, and former Deputy Director, Swedish Meteorological and Hydrological Institute.

Pictorial Parade

Sandy Seaside Beaches help make Falsterbo, on the southwestern tip of Sweden, a popular vacation area.

John LaDue

Downtown Stockholm has a modern business area. Automobiles, not permitted on the street level, are parked underground.

There, for long periods in summer, the sun shines 24 hours a day. Above the Arctic Circle is part of an unspoiled wilderness called Lapland. This region extends into Finland, Norway, and Russia. For hundreds of years, people called Lapps have led a wandering life with their herds of reindeer.

Sweden, together with Denmark and Norway, is one of the Scandinavian countries. Swedes, Danes, and Norwegians speak similar languages and can usually understand each other. The three Scandinavian nations have close economic and cultural ties, and their histories are closely linked.

FACTS IN BRIEF

Capital: Stockholm.

Official Language: Swedish.

Official Name: *Konungariket Sverige* (Kingdom of Sweden).

Form of Government: Constitutional monarchy. *Head of State*—King or Queen. *Head of Government*—Prime minister (appointed by the speaker of the parliament). *Parliament* (Riksdag)—349 members (3-year terms). *Political Divisions*—24 counties and Stockholm.

Area: 173,732 sq. mi. (449,964 km²). *Greatest Distances*—north-south, 977 mi. (1,572 km); east-west, 310 mi. (499 km). *Coastline*—4,700 mi. (7,564 km).

Elevation: *Highest*—Mount Kebnekaise, 6,926 ft. (2,111 m) above sea level. *Lowest*—sea level along the coast.

Population: *Estimated 1976 Population*—8,352,000; distribution, 82 per cent urban, 18 per cent rural; density, 49 persons per sq. mi. (19 persons per km²). *1970 Census*—8,076,903. *Estimated 1981 Population*—8,648,000.

Chief Products: *Agriculture*—barley, livestock (cattle, hogs), milk and other dairy products, oats, potatoes, rye, sugar beets, wheat. *Fishing*—cod, herring, mackerel, salmon. *Forestry*—fir, pine, spruce. *Manufacturing*—agricultural machinery, aircraft, automobiles, ball bearings, diesel motors, electrical equipment, explosives, fertilizers, furniture, glass, matches, paper and cardboard, plastics, plywood, precision tools, prefabricated houses, ships, steel, steelware, telephones, textiles, wood pulp. *Mining*—copper, gold, iron ore, lead, uranium, zinc.

National Anthem: "Du gamla, du fria" ("Thou Ancient, Thou Free-Born").

National Holiday: Flag Day, June 6.

Money: *Basic Unit*—krona. One hundred öre equal one krona. For the value of the krona in dollars, see MONEY (table: Values). See also KRONA.

Sweden is a constitutional monarchy with a king, a prime minister and Cabinet, and a parliament. Sweden had the same constitution from 1809 to 1975, when a new constitution went into effect.

The 1809 constitution had given the king most of the executive power of the government. The power of the parliament gradually increased, and parliamentary rule was adopted in 1917. Under the 1975 constitution, the king lost most of his remaining executive powers and became merely a ceremonial figure.

King of Sweden is head of state. He attends the opening of parliament and is required to be present at the meeting at which a former prime minister turns over the government to his successor.

Prime Minister and Cabinet hold the executive power in Sweden. The speaker of the parliament nominates as prime minister the leader of the majority party or group of parties in the parliament. The parliament must then confirm the appointment. The prime minister selects the members of the Cabinet.

Parliament of Sweden is a one-house body called the *Riksdag*. The people elect the Riksdag's 349 members to three-year terms. A political party must win at least 4 per cent of the total vote for its candidates to be elected to the Riksdag. A party may also receive a seat if it wins at least 12 per cent of the vote in any one election district. The Riksdag has the power to remove the entire Cabinet or an individual Cabinet member from office. The prime minister may then call for new parliamentary elections. All persons who are at least 18 years old may vote.

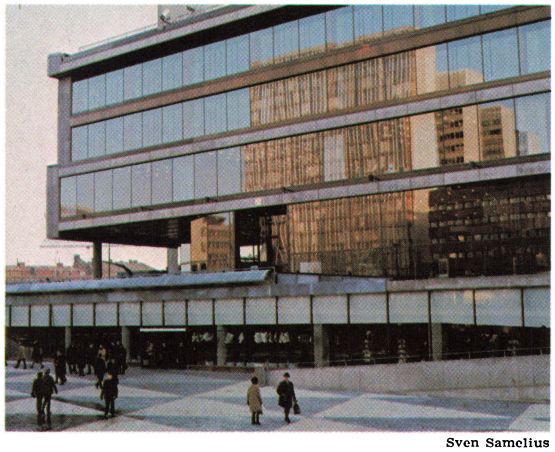
Ombudsmen. The Riksdag appoints an official called an *ombudsman* to investigate complaints by citizens against government actions or decisions. Sweden created this office in 1809, and was the first country to have an ombudsman. The Riksdag appoints a second ombudsman to investigate complaints against military authorities. This office was created in 1914. See OMBUDSMAN.

Politics. The Social Democratic Party has controlled the Swedish government since 1932, except for a short period in 1936. The Social Democrats established Sweden's welfare system. Other parties include the Center, Communist, Liberal, and Moderate Coalition parties. In 1965, the Riksdag approved an annual government payment totaling about $5 million to political parties. Each party receives a share based on its number of seats in the Riksdag.

Local Government. Sweden's 24 counties and the city of Stockholm have separate governments. Each county is administered by a governor appointed by the government and a council elected by the people. Stockholm is administered by a governor appointed by the government.

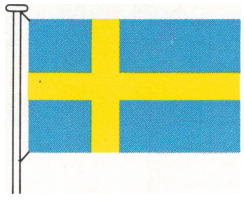
Courts. District courts serve the towns and counties of Sweden. Regional courts of appeal hear appeals from the district courts. The Supreme Court hears final appeals in important civil and criminal cases.

Armed Forces. Swedish men between 18 and 47 are required to serve at least 10 months in the armed forces. The nation's army, navy, and air force have a total of about 750,000 men.



Sven Samelius

Sweden's Parliament Building is constructed partly of glass that reflects nearby structures in downtown Stockholm.

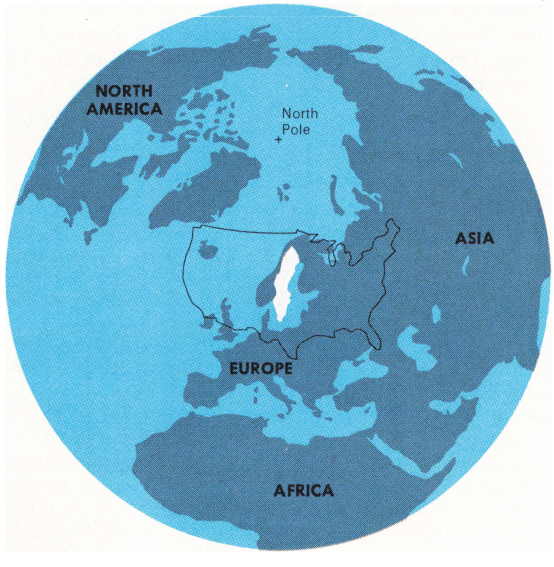


The Swedish Flag, first used in the mid-1400's, was made official in 1663. The colors come from the coat of arms.

Sweden's Coat of Arms features the three small crowns added by King Albert in 1364. It was made official in 1908.

Sweden is nearly 6 per cent as large as the United States, not counting Alaska and Hawaii. The country lies just east of Norway.

WORLD BOOK map



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Västerås ..118,065..H 4
Västervik ..42,059..I 4
Växjö .....60,130..I 4
Vetlanda ..28,741..I 4
Ystad* ....23,905..J 3

*Does not appear on map; key shows general location.
†Populations of municipalities, which may include rural areas as well as the urban center.
*Population of metropolitan area, including suburbs.
Source: Latest official estimates (1971).

The Swedes are closely related to the Danes and Norwegians. Most Swedes are tall, with fair or brown hair and blue eyes. Since World War II ended in 1945, about 500,000 persons from other European countries have settled in Sweden.

About four-fifths of Sweden's people live in cities and towns, mainly in the center and south of the country. About a third of the people live in the three largest cities —Stockholm, Göteborg, and Malmö—and their suburbs. Sweden is one of the most thinly populated countries in Europe, with an average of 49 persons per square mile (19 persons per square kilometer). Only Finland, Iceland, and Norway are less densely populated.

The Lapps, who live in the far north, differ in appearance, language, and way of life from most other Swedes (see LAPLAND). About 10,000 of these short, stocky people live in Sweden. Most Lapps are miners or lumberjacks. About 2,000 of them live as their ancestors did, wandering over the land with their herds of reindeer. About 30,000 Swedes of Finnish origin also live in the north.

Language. Swedish is a Germanic language that resembles Danish and Norwegian. People from all three countries can usually understand each other. Some people of Finnish origin who live in Sweden still speak their own language. The Lapps speak a language related to Finnish. Most Swedes speak some English.

Religion. The Lutheran Church is the state church of Sweden, and about 98 per cent of the people are members. The king must be a member. All Swedes whose parents belong to the Lutheran Church become members automatically at birth. They remain so unless they apply to withdraw. Most Swedes do not attend church regularly, but the churches are full on religious holidays.

Sweden has about 10 other large religious groups, and some of their members belong to the Lutheran Church as well. These groups, in order of size, include the Missionary Union, the Pentecostal Movement, Baptists, and Methodists. Other religious groups in Sweden include Roman Catholics and Jews.

The churches pioneered much welfare work in the country, but the government has taken over most of this work. Swedish churches have a long tradition of missionary activities, particularly the Lutheran Church in India and South Africa.

Food. Sweden is famous for *smörgåsbord*, an assortment of cold and hot foods placed on a large table for self-service. Swedes often eat the foods in a certain order. First they eat cold fish dishes, including anchovies, eels, herring, salmon, sardines, and shrimp. They follow the fish with such cold meats as liver pâté, smoked reindeer, and ham with vegetable salad. Next come small hot dishes, such as meatballs, omelets, sausages, and anchovies or herring cooked in breadcrumbs. Desserts include cheese and fresh fruit, fruit salad, and pastry.

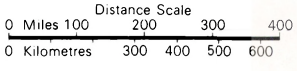
Education. The Swedish government, with the goal of expanding and improving educational services, completely reorganized the nation's school system during the 1960's. Most children receive a free education at schools operated by the government. The government also operates all the universities and most of the technical and other specialized colleges.

Many children under the age of 7 attend kindergartens run by private persons or organizations. The government assists the kindergartens, but attendance is not required.

Children from 7 to 16 must attend a school called

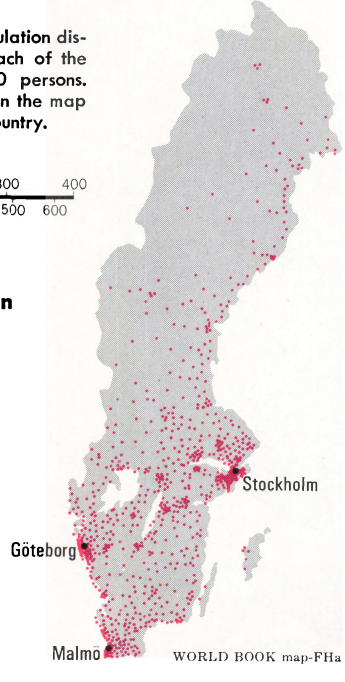
POPULATION

This map shows the population distribution of Sweden. Each of the dots represents 10,000 persons. The three cities shown on the map are the largest in the country.



Historical Population

1981	Estimate	8,648,000
1976	"	8,352,000
1970	Census	8,076,903
1960	"	7,495,316
1950	"	7,041,829
1940	"	6,371,432
1930	"	6,142,191
1920	"	5,904,489
1910	"	5,522,403
1900	"	5,136,441
1850	"	3,482,541
1800	"	2,347,303
1750	Estimate	1,780,678



WORLD BOOK map-FHa

Farm Families own about 80 per cent of Sweden's farms, and rent the rest. Most of them live in the southern third of the country. Less than 10 per cent of the labor force are farmers.

WORLD BOOK photo by Nils-Johan Norenlind

a *grundskola*. The grundskola system, which was introduced in 1962, has three three-year divisions. The *junior stage* consists of first grade through third grade, and the *intermediate stage* covers fourth grade through sixth grade. The *senior stage* consists of seventh through ninth grade. In the seventh and eighth grades, students begin to choose their own subjects. In the ninth grade, they select one of nine courses of study. Most pupils continue their general education. Others also learn such practical skills as home economics or workshop methods. Some select special courses in languages, technology, or commerce. Every child in the fourth through seventh grade is required to study English, and about 90 per cent continue English after that.

Following the grundskola, some children go to a secondary school. Since 1966, there have been three kinds of secondary schools. The three-year *upper secondary schools* prepare students to attend a university. The two-year *continuation schools* give courses in social, economic, and technical subjects. The *vocational schools* offer day and evening courses for one to three years in such subjects as industry, handicrafts, and home economics.

Sweden has six universities—in Göteborg, Linköping, Lund, Stockholm, Umeå, and Uppsala. The oldest, the University of Uppsala, was founded in 1477.

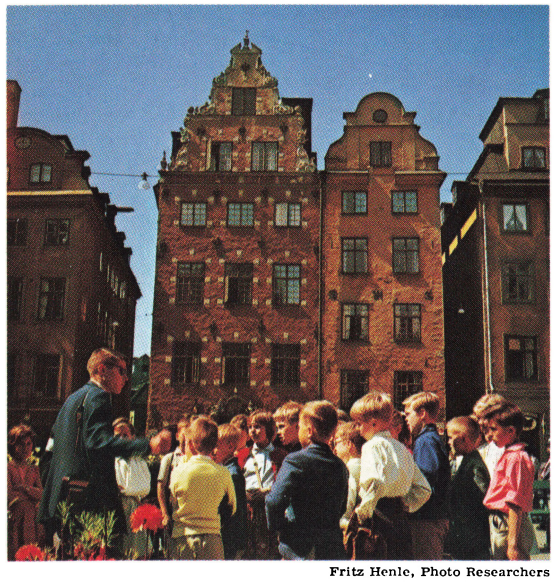
Libraries and Museums. Sweden has four general research libraries—the Royal Library in Stockholm and the university libraries in Göteborg, Lund, and Uppsala. The Royal Library, established in the 1600's, has

Swedish Lumberjacks often float logs down rivers to coastal sawmills. About half of Sweden's forests are privately owned, mostly by farmers. Many farmers work part time as lumberjacks.

Franklin Photo Agency

Franklin Photo Agency

Vacation Lodges dot much of the Swedish countryside. About 350,000 families own vacation homes. The Swedes spend more money per person on vacations than any other Europeans.



Fritz Henle, Photo Researchers

Swedish Schoolchildren visit the public square of the old section of Stockholm. There, in 1520, King Christian II of Denmark executed many Swedes who had rebelled against Danish rule.

Gymnastics are required in Swedish schools. Many adults do these graceful exercises during lunch-hour drills. Music for gymnastics is broadcast daily for housewives.

C. A. Peterson, Rapho Guillumette

a large collection of early Swedish manuscripts. Sweden also has about 3,800 public libraries.

Leading museums include the Skansen open-air museum, which exhibits old Swedish houses, and the Nationalmuseum, which has a collection of Swedish sculpture and paintings. Both museums are in Stockholm.

Sports. The Swedes are an athletic people and like outdoor activities. Many spend their vacations by the sea or on the country's offshore islands. Others relax near one of Sweden's many lakes or in the vast wilderness that covers the northern part of the country. Tourists enjoy three-day trips along the Göta Canal, which flows 240 miles (386 kilometers) across southern Sweden. This canal links lakes and rivers, and connects Göteborg with the Baltic Sea.

Cross-country skiing and hockey are the chief winter sports. Every March, thousands of Swedes take part in a ski run called the Vasa Race, held in the province of Dalarna. The run covers 55 miles (89 kilometers). Sportsmen hunt deer, fox, moose, and various wildfowl, and fish for pike, salmon, and trout. When the rivers are frozen, fishermen cut holes in the ice and drop their lines through them. The people also like hiking and camping, soccer, swimming, and yachting. Graceful gymnastics called *calisthenics* are popular in Sweden, and are a feature of school training.

Holidays. The main winter festivals in Sweden take place in December. On December 13, the Swedes celebrate St. Lucia Day, the Festival of Light. Before dawn, young girls dress in white with a crown of evergreen leaves. They awaken their families with a traditional song and serve them hot coffee and buns. The main Christmas celebration is on Christmas Eve. Families gather for dinner, which usually includes ham and a fish course. After dinner, everyone receives his presents. See CHRISTMAS (color picture: A Swedish Boy).

Midsummer's Eve festivities are held on the Friday between June 19 and 26. The people celebrate the return of summer to Sweden. They stay up most of the night and dance around gaily decorated Maypoles. Flag Day, the national holiday, is June 6. The king presents the national flag to Swedish organizations and societies at a special ceremony.

Social Welfare. The Swedes pay high taxes, but the government provides many welfare benefits. Every family receives an allowance for (1) each child under 16 and (2) each child in a secondary school or university. The government helps newly married couples by providing loans for home furnishings. In some cases of hardship, it pays up to a fourth of a family's rent. The government guarantees every employed person a four-week annual vacation with pay. Some housewives with low incomes receive allowances for vacations with their children.

Swedes who lose their jobs receive unemployment benefits representing a high proportion of their former earnings. The people have largely free medical service. After retirement, most Swedes receive annual pensions of about 60 per cent of their average earnings during their 15 highest paid years. The government also provides pensions for widows, orphans, and children who have lost one parent.

Most Swedish art forms have long been influenced by artistic developments in other parts of Europe. During the 1900's, distinctive Swedish styles have appeared in the fields of architecture and design. Swedish architects and town planners have worked together to create towns and suburbs. These communities have won international fame as models of architectural planning and design.

In 1964, the government set up a system of grants to increase the income of artists who need help. The government also supports three theater schools and a motion-picture school.

The playwright August Strindberg, who wrote *The Father* and *Miss Julie*, was the first Swedish writer to win international fame. The novelist Selma Lagerlöf wrote charming, romantic novels and a classic children's book, *The Wonderful Adventures of Nils*. She was the first Swedish writer to win a Nobel prize.

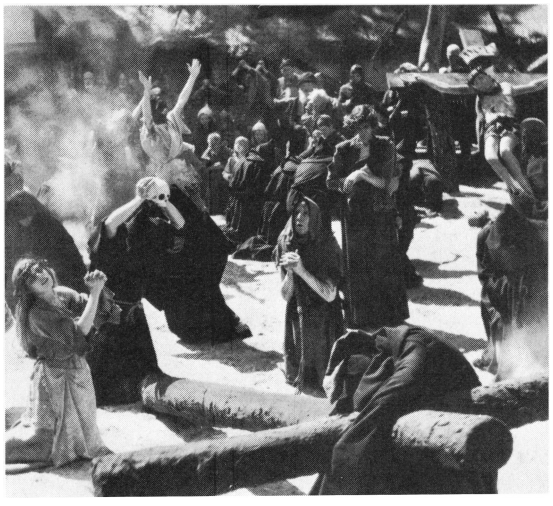
During the 1600's and 1700's, French painters working in Sweden greatly influenced the development of Swedish painting. Alexander Roslin, who produced brilliant portraits, is the best-known Swedish painter of

The Plays of August Strindberg are performed in most parts of the world. He wrote *Miss Julie*, one of his most famous dramas, in 1888. Strindberg was also a novelist and story writer.

The Royal Dramatic Theater, Stockholm (Swedish Tourist Bureau)

Swedish Motion Pictures are known for their high quality *The Seventh Seal* and other films directed by Ingmar Bergman are especially outstanding. Bergman writes most of his own scripts.

A. B. Svensk Filmindustri



that period. French impressionism inspired Karl Fredrik Hill and Ernst Josephson in the late 1800's. Some critics consider them Sweden's greatest painters. Today, most Swedish painters follow international trends in abstract art.

The Swedish sculptor Carl Milles worked for many years in the United States, where he achieved a world-wide reputation for outdoor sculptures, particularly fountains. Most other leading Swedish sculptors use abstract forms in their work.

Swedish designers have produced home furnishings of artistic merit. Many homes in the United States are furnished in a style known as *Swedish modern*. Swedish furniture is simple in style, and most of it is made of light-colored wood. Designers use pleasant, bright colors for upholstery and drapery materials. Other Swedish furnishings with international fame for beauty include glassware, pottery, and silverware. Swedish glass vases, bowls, and other products are especially famous for their graceful design and high quality. The towns of Kosta and Orrefors, in southeastern Sweden, are the country's main glassmaking centers.

Fritz Henle, Photo Researchers

Statues by Carl Milles attract many visitors to Millesgården, a park near Stockholm that includes his old home and studio.

Lapp Handicrafts, produced in Lapland in northern Sweden, feature beautifully carved bone and wood.

Pal-Nils Nilsson, J. D. Studios Ltd.

A Great Cultural Movement took place in Sweden during the rule of King Gustavus III (1771-1792). Literature especially flourished. This painting shows the crowning of Gustavus, who wrote poems and plays.

Coronation of Gustavus III by Carl Gustav Pilo. Nationalmuseum, Stockholm

Swedish Industrial Arts, including home furnishings, are known for their simple, graceful design.

J. D. Studios Ltd.

Sweden occupies the eastern part of the Scandinavian peninsula. From Sweden's hilly and, in parts, mountainous border with Norway, the land slopes gently eastward to the Gulf of Bothnia and the Baltic Sea. The country's scenery varies from the unpopulated, treeless Kölen Mountains in the northwest to the fertile plains in the south. Thousands of lakes cover about a twelfth of the country's area.

The long Swedish coastline has sandy beaches in the south, and rocky cliffs in parts of the west and north. Many groups of small islands lie off the coast. Sweden's largest islands are Gotland, a fertile island covering about 1,160 square miles (3,004 square kilometers), and Öland, which covers about 520 square miles (1,350 square kilometers). Both islands are in the Baltic Sea.

Sweden has four main land regions: (1) the Mountain Range, (2) the Inner Northland, (3) the Swedish Lowland, and (4) the South Swedish Highland.

The Mountain Range is part of the Kölen Mountains. Sweden's northern boundary with Norway runs through these mountains, which Norwegians call the Kjølen Mountains. Hundreds of small glaciers cover the higher slopes of the snow-capped range. Sweden's highest mountain, 6,926-foot (2,111-meter) Mount Kebnekaise, is in this rugged region.

The land is completely treeless above about 1,600 feet (488 meters) in the northernmost part of the mountains. There, the climate is too cold for trees. Some birch trees grow on the warmer lower slopes.

The Inner Northland is a vast, thinly populated, hilly region. Great forests of pine and spruce trees cover most of the land, and lumbering is an important industry. Many swift rivers flow southeast across the Inner Northland, and provide much hydroelectric power. The rivers have formed deep, narrow valleys, some of which have long lakes. The valleys broaden toward the coast of the Gulf of Bothnia. Most of the region's people live in these valleys or on the coast.

The Torne River forms part of the boundary between the Inner Northland and Finland. Other rivers in the region include the Lule, the Ume, the Ångerman, and the Dal rivers. Bergslagen, a hilly area rich in minerals, lies south of the Dal River in the southernmost part of the Inner Northland.

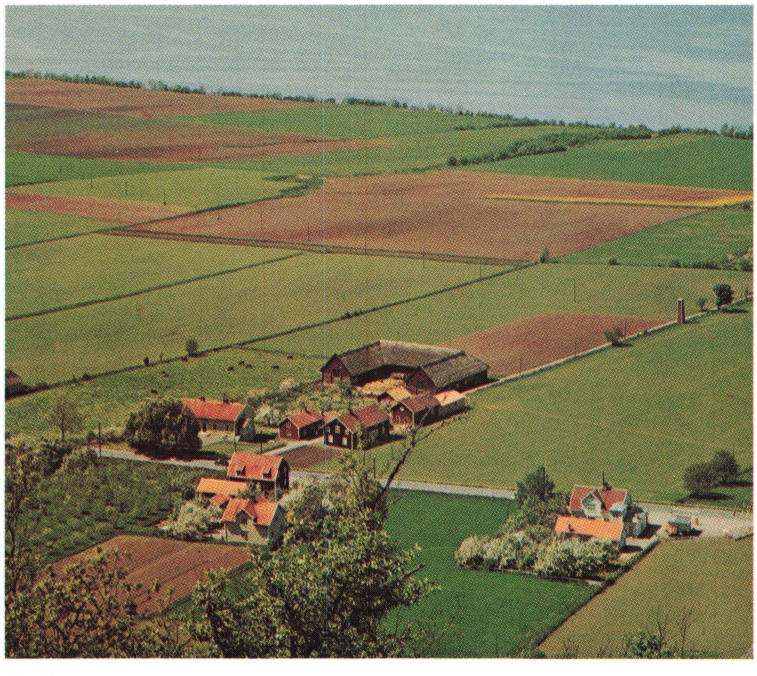
The Swedish Lowland has more people than any other part of the country. This region includes the central and southern plains of Sweden. The broad central plains are broken by lakes, tree-covered ridges, and small hills. Farmland covers more than 40 per cent of these plains. Sweden's largest lakes, Vänern and Vättern, are there. Lake Vänern covers 2,156 square miles (5,584 square kilometers), and is one of the largest lakes in Europe. Lake Vättern has an area of 738 square miles (1,911 square kilometers).

The southern plains include some of Sweden's most fertile land. Farmland and beech woods cover most of Skåne, in the far south. It is the most thickly populated and richest farming area of Sweden.

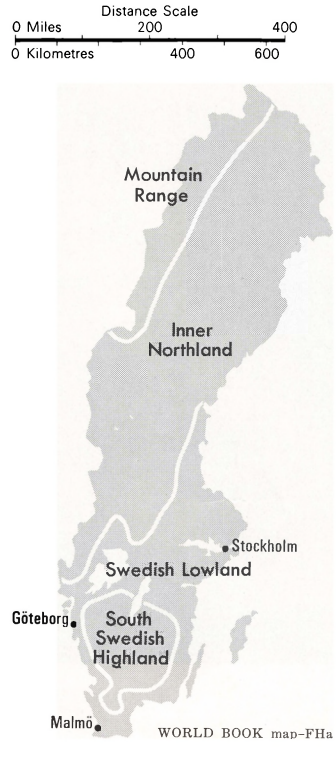
The South Swedish Highland, also called the *Götaland Plateau*, is a rocky upland that rises to about 1,200 feet (366 meters) above sea level. This thinly populated area has poor, stony soils, and is covered mostly by forests. The southern part of the region is flat, with small lakes and swamps.

The Swedish Lowland includes most of Sweden's croplands, such as these fertile plains near Lake Vättern. Many lakes and small hills break up the region's central plains.

Herbert Fristedt from Carl Ostman



LAND REGIONS OF SWEDEN



Physical Features

Ångerman River	D 6
Arctic Circle	B 8
Baltic Sea	G 7
Dal River	E 5
Fax River	D 6
Gävle Bay	E 6
Göta Canal	F 5
Gotland (Island)	G 7
Gulf of Bothnia	E 7
Hanö Bay	H 5
Helagsfjället (Mountain)	D 4
Indals River	D 6
Kalix River	B 8
Kalmar Sound	G 6
Kattegat (Channel)	G 3
Kebnekaise (Mountain)	B 7
Klar River	E 4
Lake Hjälmaren	F 6
Lake Hornavan	B 6
Lake Kall	D 4
Lake Siljan	E 5
Lake Stor	D 4
Lake Stora Lule	B 7
Lake Storavan	C 7
Lake Storuman	C 6
Lake Torne	A 7
Lake Vänern	F 4
Lake Vättern	F 5
Lagan River	G 4
Lainio River	A 8
Lule River	B 8
Nissan River	G 4
Öland (Island)	G 6
Pite River	C 8
Sånfjället (Mountain)	D 4
Sarjektjåkko (Mountain)	B 6
Skellefte River	C 7
Sulitelma (Sulitjelma) Mountains	B 6
Torne River	B 9
Ume River	C 7
Västerdal River	E 4
Vindel River	C 7

The climate of Sweden varies greatly between the southern and northern parts of the country. Southwesterly winds from the Atlantic Ocean give southern Sweden pleasant summers and mostly mild winters. Northern Sweden has pleasant summers but cold winters. The Atlantic winds are blocked by the Kölen Mountains, and have less effect on northern Sweden.

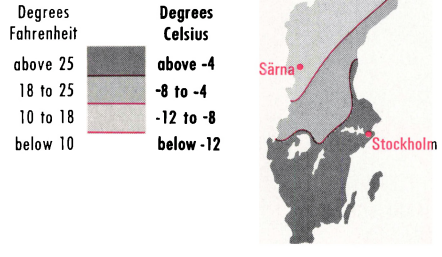
In the extreme south, temperatures in January and February, the coldest months, average 32° F. (0° C). In Kiruna, in the far north, temperatures average about 10° F. (−12° C) during these months. In July, Sweden's warmest month, temperatures average from 59° to 63° F. (15° to 17° C) in the south, and 54° to 57° F. (12° to 14° C) in the north. In winter, eastern air masses may lower the temperature to −10° F. (−23° C) in Stockholm, and to −45° F. (−43° C) in the north.

Rainfall is generally greater in the Kölen Mountains and the southern highlands than on the plains that border the Gulf of Bothnia. In the south, snow covers the ground in January and February. The north has snow from mid-October through mid-April.

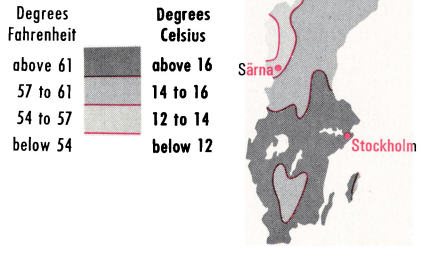
Pictorial Parade

Cross-Country Skiing is a favorite sport in Sweden, where snow covers the ground from two to six months a year.

AVERAGE JANUARY TEMPERATURES

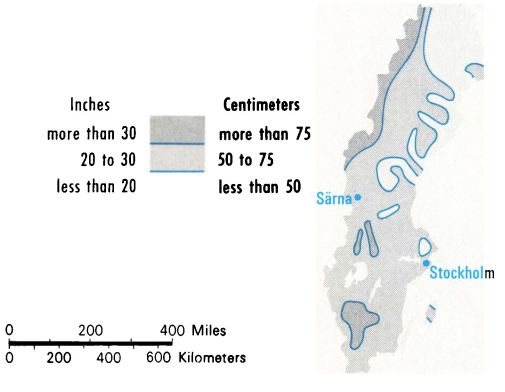


AVERAGE JULY TEMPERATURES



AVERAGE YEARLY PRECIPITATION

(Rain, Melted Snow and Other Moisture)



WORLD BOOK maps
Sources: Meteorological Office, London; U.S. Navy

AVERAGE MONTHLY WEATHER

STOCKHOLM	Temperatures F°		Temperatures C°		Days of Rain or Snow
	High	Low	High	Low	
JAN.	31	23	-1	-5	8
FEB.	31	22	-1	-6	7
MAR.	37	26	3	-3	7
APR.	45	32	7	0	6
MAY	57	41	14	5	8
JUNE	65	49	18	9	7
JULY	70	55	21	13	9
AUG.	66	53	19	12	10
SEPT.	58	46	14	8	8
OCT.	48	39	9	4	9
NOV.	38	31	3	-1	9
DEC.	33	26	1	-3	9

SÄRNA	Temperatures F°		Temperatures C°		Days of Rain or Snow
	High	Low	High	Low	
JAN.	19	4	-7	-16	8
FEB.	24	5	-4	-15	5
MAR.	33	11	1	-12	5
APR.	42	23	6	-5	7
MAY	56	32	13	0	6
JUNE	63	41	17	5	11
JULY	69	46	21	8	13
AUG.	65	44	18	7	12
SEPT.	54	36	12	2	10
OCT.	42	28	6	-2	9
NOV.	30	19	-1	-7	9
DEC.	24	11	-4	-12	9

Sweden's economy is based mainly on its three most important natural resources—timber, iron ore, and water power. The large Swedish merchant shipping fleet transports cargoes to and from all parts of the world, and provides an important source of income for the nation. About 90 per cent of Swedish industry is privately owned. For Sweden's rank in the output of various products, see the articles listed under Products and Industry in the *Related Articles* at the end of this article.

Natural Resources. The raw materials for Sweden's industries come chiefly from the country's vast forests and rich deposits of iron ore. Waterfalls, rapids, and dams provide most of the nation's electricity. Although

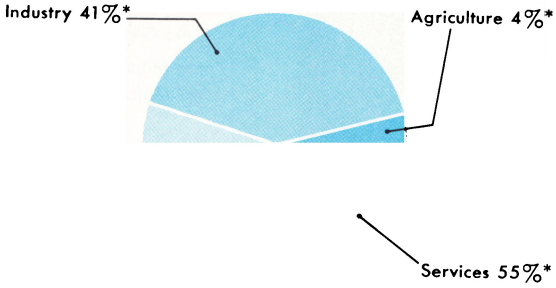
FARM, MINERAL, AND FOREST PRODUCTS

This map shows where the leading farm, mineral, and forest products of Sweden are produced. Most Swedish agriculture is in the southern parts of the country and on the central plains. The map also shows five important manufacturing centers.

WORLD BOOK map-FHa

SWEDEN'S GROSS NATIONAL PRODUCT

Total gross national product in 1970—$32,581,000,000



The Gross National Product (GNP) is the total value of goods and services produced by a country in a year. The GNP measures a nation's total annual economic performance. It can also be used to compare the economic output and growth of countries.

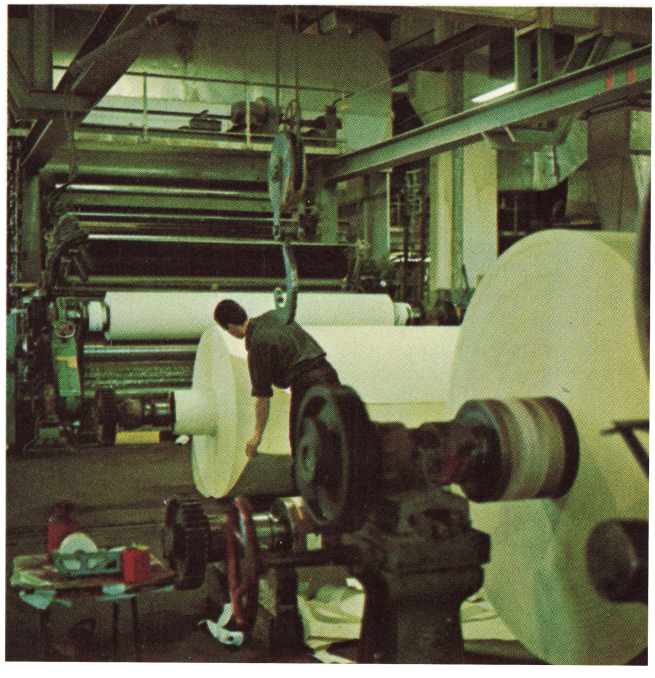
Production and Workers by Economic Activities

Economic Activities	Per Cent of GDP* Produced	Employed Workers	
		Number of Persons	Per Cent of Total
Manufacturing	29	1,023,000	26
Community, Business & Personal Services	21	301,000	8
Banking, Insurance & Real Estate	15	191,000	5
Hotels, Restaurants & Trade	12	569,000	15
Construction	9	372,000	9
Transportation & Communication	7	264,000	7
Agriculture, Forestry & Fishing	4	352,000	9
Utilities	2	49,000	1
Mining	1	†	†
Government	**	772,000	20
Total	100	3,893,000	100

*Gross domestic product. GDP is gross national product less net income from abroad.
†Included with Utilities.
**Included with Community, Business & Personal Services.
Source: *The Swedish Economy, Autumn 1971*, National Institute of Economic Research, Stockholm

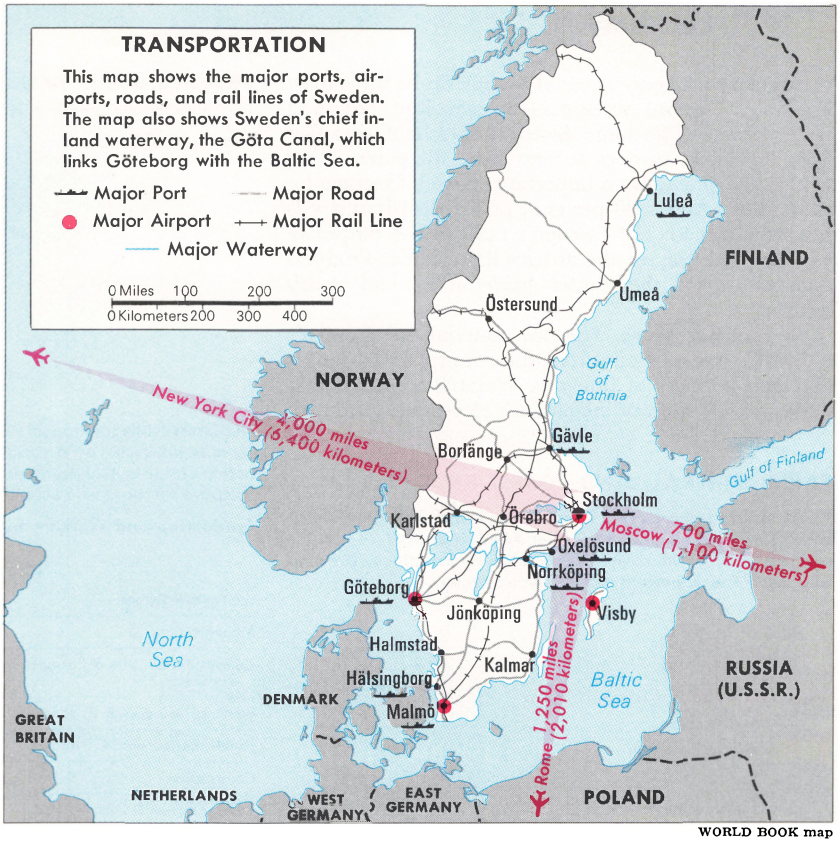
Sweden Is a World Leader in Paper Production.

Herbert Fristedt from Carl Östman



John LaDue

Sweden's Major Seaport is Göteborg, which is also the chief shipbuilding center. Shipping and shipbuilding are important sources of income.



WORLD BOOK map

most of Sweden is too cold and infertile for farming, farmers produce most of the people's food.

Forests cover more than half of Sweden, and more than a fourth of the nation's exports are lumber or products made of wood. The main lumber regions are in the north and north-central sections, where the most important trees include fir, pine, and spruce. Much lumber is carried to manufacturing plants by truck and railroad. Logs are also floated down the rivers to sawmills on the coast, where some lumber is exported and the rest is sent to industrial centers. Forestry is less important in southern Sweden, even though oak, beech, and other trees cover large areas.

Minerals. Sweden has some of the richest iron ore deposits in the world. Sweden's total iron ore resources have been estimated at about $3\frac{1}{3}$ billion short tons (3 billion metric tons), of which about 60 per cent is near Kiruna in Lapland. The Lapland mines have some of the world's best high-grade ores. Most of the Lapland ore is exported. The Swedish iron and steel industry gets most of its ore from the Bergslagen district, south of the Dal River. The Skellefteå region in northern Sweden has copper, lead, gold, and silver. Some low-grade uranium ore is mined in central Sweden. The country has a few deposits of low-grade coal.

Water Power provides about 95 per cent of Sweden's electricity. The largest hydroelectric power stations are in northern Sweden. Most of them are underground, and can be operated throughout the year. Other important power stations are in central and southern Sweden, including a large station at Trollhättan.

Farmland covers only about 10 per cent of Sweden. A region called Skåne, in the extreme south, has a good climate and is the most fertile area. Other agricultural areas are in the south and around the lakes in central Sweden. Less than 1 per cent of the Inner Northland region is cultivated.

Manufacturing industries are scattered throughout central Sweden and western Skåne, and along the coast. The iron and steel industry produces high-quality steel, which is used for such products as ball bearings, stainless steel goods for the home, precision tools, and watch springs. Steel is widely used in the engineering industry, which accounts for more than a third of Sweden's total industrial production and for two-fifths of its exports.

Important Swedish engineering products include agricultural machinery, aircraft, automobiles, and ships. Linköping is the chief center of the aircraft industry, and Trollhättan has aircraft engine and diesel motor plants. Stockholm, Göteborg, and Linköping have major automobile plants. Nearly half the automobiles made in Sweden are exported to the United States. Sweden ranks second only to Japan in the number of ships it builds for export. The main shipbuilding centers are Göteborg and Malmö. The electrical engineering industry makes equipment for power supplies and communications, and telephones are an important export.

Sweden produces about 10 per cent of the world's

wood pulp. Other important products based on timber include paper and cardboard, prefabricated houses, plywood, and furniture.

The Swedish chemical industry imports most of its raw materials. The chief products include explosives, fertilizers, plastics, and safety matches. Safety matches were invented in Sweden in 1844, and the country is still one of the world's leading producers.

Agriculture. Dairy farming and livestock raising are the main sources of income for Swedish farmers. Milk and meat are the leading farm products. The chief crops include barley, oats, potatoes, sugar beets, and wheat. Almost all the farmers belong to Sweden's agricultural cooperative movement. The cooperatives collect, process, and market farm products (see COOPERATIVE).

Mining. Sweden's most important mineral is iron ore. The country is a leading producer of this mineral, which accounts for 6 per cent of Sweden's exports. Most of the exported ore comes from mines in Lapland. In summer, the Lapland ore is shipped from the port of Luleå, on the Gulf of Bothnia. In winter, Luleå's harbor is icebound, and the ore must be carried across the mountains to the ice-free port of Narvik in Norway.

Foreign Trade. The value of Sweden's imports is greater than that of its exports. But in most years, income from the country's merchant shipping fleet makes up most of the difference. The chief Swedish exports include engineering products, wood pulp, paper and other wood products, iron ore, and steel. Imports include coal, petroleum, and foodstuffs.

West European nations, including Denmark, West Germany, Great Britain, The Netherlands, and Norway, account for more than 80 per cent of Sweden's exports and more than 75 per cent of its imports. Sweden also has important trade with the United States. Sweden is a member of the European Free Trade Association (see EUROPEAN FREE TRADE ASSOCIATION).

Transportation. The government owns about 95 per cent of Sweden's 8,450 miles (13,600 kilometers) of railways. Only a little more than half are electrified, but electric trains carry about 90 per cent of the total railroad traffic. Ferries connect Swedish railroads with those in Denmark and Germany. Sweden has a network of good roads and highways, and trucks carry almost as much freight as the railroads do.

Stockholm has an international airport at Arlanda. Other important airports serve Göteborg and Malmö. Swedish ships carry raw materials between coastal towns.

Communication. Sweden has about 160 daily newspapers, with a total daily circulation of more than 4 million. *Expressen* of Stockholm, with a circulation of about 455,000, is the largest newspaper in Sweden. Most of Sweden's newspapers are privately owned. Freedom of the press is guaranteed by law, and government censorship is forbidden even in wartime.

The Swedish Broadcasting Corporation, which operates three radio stations and one television channel, is the only broadcasting system. It is run partly by the government, but is nonpolitical. The government does not permit advertising on radio or television.

Sweden's telephone and telegraph services are operated by the government. In the mid-1970's, Sweden had about 590 telephones for every 1,000 persons.

SWEDEN / *History*

Early Times. Sweden was one of the last regions to lose the ice that covered most of Europe thousands of years ago. The ice had melted by about 6000 B.C., and hunters and fishermen from south of the Baltic Sea settled in the southern tip of Sweden. People moved farther north as the climate improved.

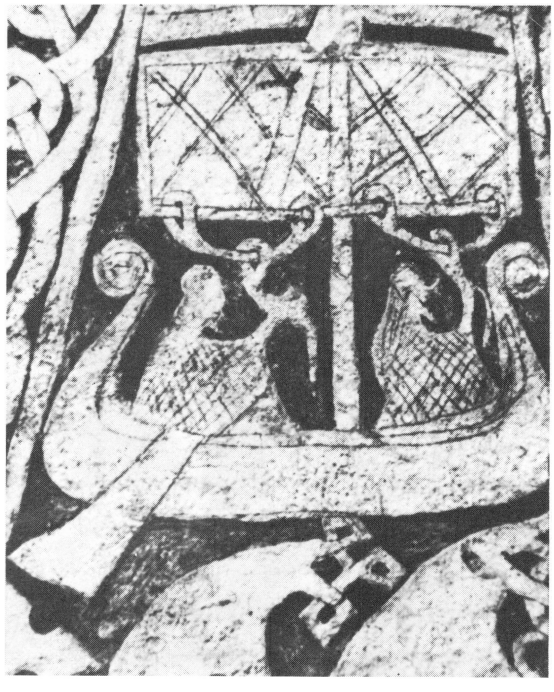
Beginning about 50 B.C., the people traded with the Roman Empire. They exchanged furs and amber for glass and bronze objects and silver coins. The Romans were the first people to make written records about the Swedes. About A.D. 100, the Roman historian Tacitus wrote about the Svear, a Scandinavian people. *Sverige* (Sweden) means *land of the Svear.*

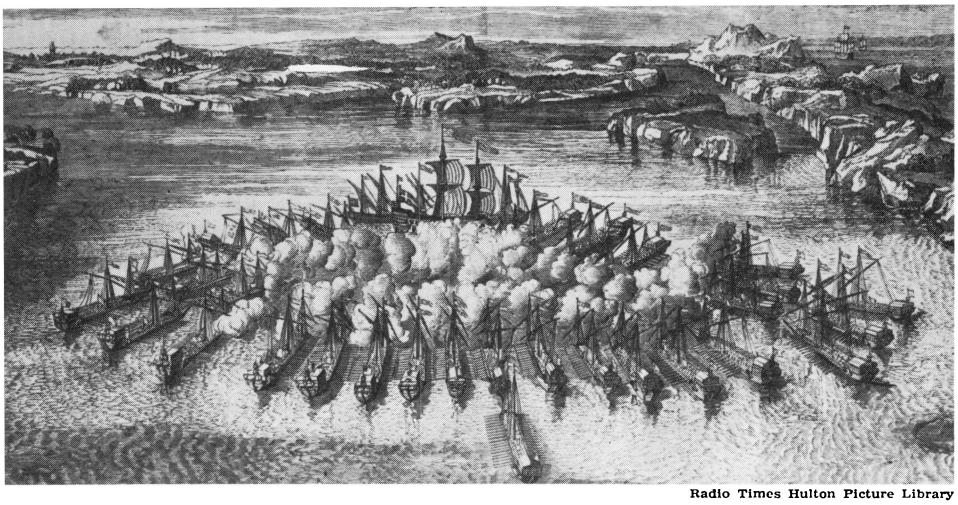
The Swedish Vikings. Beginning about A.D. 800, Scandinavian adventurers called *Vikings* sailed to many parts of the world. They acquired wealth by trade and conquest. Most of the Norwegian and Danish Vikings sailed westward. The Swedish Vikings went eastward across Russia, as far as the Black and Caspian seas. The Swedes traded slaves and furs for gold, silver, and luxury goods. The Viking expeditions lasted until the 1000's. Much of Sweden's trade with the east then came into the hands of German merchants, who settled in the town of Visby on the island of Gotland. See VIKING (The Swedish Vikings); RUSSIA (Early Days).

The Early Kingdom. Christianity was first preached in Sweden in A.D. 829 by Saint Anskar, a Frankish monk. His missionary work began a struggle between Christianity and paganism that lasted about 200 years. The first Christian king of Sweden was Olof Skotkonung, who ruled from the late 900's until the early 1000's. Christianity brought about great changes in Sweden. The clergy founded schools, encouraged the arts, and set down Sweden's laws in writing.

By the 1000's, Sweden, Denmark, and Norway had become separate kingdoms. Sweden began to develop along partly feudal lines (see FEUDALISM). There were three social classes—the clergy, the nobles, and the

Picture Stones were carved by Swedish Vikings, usually as memorial monuments for heroes. This picture dates from the A.D. 700's.
Picture stone from Gotland. Historiska Museet, Stockholm





Battle of Hangö, during the Great Northern War, ended in victory for Russia's navy over the Swedish fleet in 1714.

Radio Times Hulton Picture Library

peasants. Above them was the king, who was elected by the provincial lawmaking assemblies. In 1249, Sweden conquered much of Finland.

Union with Norway and Denmark. During the 1200's and 1300's, constant struggles took place between the rulers of Sweden and the nobles. In 1388, to oppose the growing German influence in Sweden's affairs, the nobles turned for help to Queen Margrete of Denmark and Norway. The Germans were defeated in 1389, and the three Scandinavian countries were united under Margrete in 1397.

A treaty called the *Union of Kalmar* laid down the conditions of the union between the three countries. This treaty provided for a common foreign policy, but separate national councils and the continuation of existing laws in each country. Except for a few short periods of separation, the union lasted over 100 years.

Under the influence of German merchants, Sweden's economy developed considerably during the 1200's and 1300's. These merchants developed Sweden's mineral resources and controlled Swedish trade. Plague wiped out a large part of Sweden's population in 1350, and caused an economic decline. The German merchants, with their powerful association called the Hanseatic League, increased their control of Swedish trade (see HANSEATIC LEAGUE).

During the late 1400's, the *Riksdag* (parliament) developed into a lawmaking and tax-raising body. Members of a new social class, the merchants, joined the other three classes as members of the Riksdag.

The Beginnings of Modern Sweden. The union with Norway and Denmark continued throughout most of the 1400's. But many struggles took place between supporters and opponents of the union. Gustavus Vasa, a Swedish noble, finally broke away from the union in 1523 after defeating the Danes. He became King Gustavus I of independent Sweden that year. Norway remained under Danish rule.

Gustavus encouraged the followers of Martin Luther, the German religious reformer, to spread their ideas. About 1540, the Lutheran religion became the state religion of Sweden. Gustavus also increased the power of the throne and laid the foundations of the modern Swedish state. He centralized the administration, dealt harshly with revolts, built an efficient army, and encouraged trade and industry. See GUSTAVUS (I).

The Age of Expansion. Beginning in the late 1500's, the Swedes fought a series of wars to gain control of the lands surrounding the Baltic Sea. King Gustavus Adolphus won many victories for Sweden and the Protestant cause in the Thirty Years' War (see THIRTY YEARS' WAR). Sweden gained new possessions in Europe, and these led to continual wars against Denmark, Poland, and Russia. In 1658, under the Treaty of Roskilde, the Swedes forced the Danes to give up their provinces on the Swedish mainland.

Charles XII, who ruled from 1697 to 1718, won many victories, and for a time made Sweden one of the greatest powers in Europe. But in 1709, Czar Peter the Great of Russia defeated the Swedes in the Battle of Poltava. During the next few years, Sweden lost most of its European possessions. See CHARLES (XII).

The Age of Liberty. Charles XII died in 1718. Before agreeing to elect a new king, the Riksdag insisted that any monarch chosen should accept a new constitution.

IMPORTANT DATES IN SWEDEN

c. 6000 B.C. The first settlers came to Sweden.

c. A.D. 800's to 1000's Swedish Vikings attacked other countries, and traded and colonized.

c. 1000 Christianity was introduced into Sweden.

1397 Sweden, Denmark, and Norway were united in the Union of Kalmar.

1523 Gustavus Vasa was elected king and Sweden became independent.

c. 1540 Lutheranism became Sweden's official religion.

1630-1632 Gustavus Adolphus won victories for Sweden in the Thirty Years' War (1618-1648).

1709 Swedish power declined after the Battle of Poltava.

1809 Sweden lost Finland to Russia. A new constitution was adopted.

1814 Sweden gained Norway from Denmark.

1905 Norway dissolved its union with Sweden.

1914-1918 Sweden was neutral in World War I.

1920 All persons at least 21 years old received the vote.

1939-1945 Sweden remained neutral in World War II.

1959 Sweden and six other nations formed the European Free Trade Association.

1963 Atomic power was used to heat some Swedish homes.

1965 The voting age was lowered to 20 years.

1975 Sweden adopted a new constitution that greatly reduced the power of the king and lowered the voting age to 18.

This constitution, which was passed in 1720, transferred many of the crown's powers to the Riksdag. The period of parliamentary government that followed was called the Age of Liberty, and lasted until 1772. That year, an unsuccessful war in Germany and serious economic and political troubles at home resulted in a peaceful revolution that re-established the power of the king.

The Napoleonic Wars. Because of its growing trade with Great Britain, Sweden became involved in wars against the French Emperor Napoleon in the early 1800's. As a result of these wars, Sweden lost Finland to Russia, but gained Norway from Denmark. In 1809, Sweden adopted a new constitution. In 1818, Jean Baptiste Bernadotte, a former French general who had become *regent* (acting ruler) of Sweden during the Napoleonic Wars, was elected king of Sweden as Charles XIV. Sweden's present royal family is descended from him.

Industrial Growth. Great economic and social changes occurred during the 1800's. More land was brought into use for farming. But food was often in short supply because of a great increase in the population. There were not enough jobs, and nearly 450,000 persons left Sweden between 1867 and 1886. Most went to the United States and settled mainly in the Midwest.

Emigration decreased after Sweden developed manufacturing, mining, and forest industries. Engineers built many railroads in the 1860's and 1870's, and Sweden's lumber resources were put into use. In 1867, Alfred Nobel, a Swedish chemist, invented dynamite, which speeded the growth of mining. Engineering industries based on iron and steel were developed. By 1900, Sweden had become an important industrial nation.

In 1905, Norway broke away from Sweden. The Norwegians elected a king, and Sweden recognized Norway's independence. See NORWAY (Independence).

Sweden was neutral during World War I (1914-1918) and World War II (1939-1945). After Germany conquered Norway in 1940, Sweden allowed German occupation troops to pass through on their way to Norway. Many Swedes opposed this policy, and Sweden stopped it in 1943. Sweden joined the United Nations in 1946.

Sweden Today is one of the most prosperous countries in the world. The Swedish economy grew rapidly during the 1960's—about 5 per cent a year. In the late 1960's, however, the nation faced sharply rising prices and a severe housing shortage. Sweden's high standard of living is spread throughout the lower income groups by means of a huge government welfare system. This program, rapidly developed since the mid-1940's, accounts for about a third of the national budget.

Some critics of the government welfare program say it gives the people too much security and makes their lives empty and boring. But most Swedes support the system, and deny it has that effect.

In 1969, Tage Erlander retired as Social Democrat Party leader and as prime minister. Olof Palme succeeded him as party leader and became the new prime minister. Palme and the Social Democrats remained in power after winning parliamentary elections in 1973. A new constitution took effect in Sweden in 1975. It greatly reduced the king's power and lowered the voting age from 19 to 18.

TORSTEN HENRIKSSON, JOHAN HENRIK NORRBIN, ISTVÁN VUKOVICH, and CARL-CHRISTIAN WALLÉN

SWEDEN / *Study Aids*

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Baltic Sea
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Torne River

PRODUCTS AND INDUSTRY

For Sweden's rank among other countries in production, see the following articles:

Forest and Forest Products
Iron and Steel
Lumber
Match
Ship

OTHER RELATED ARTICLES

Air Force (Sweden)
Christmas (In Sweden; color picture: A Swedish Boy)
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Outline

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IV. The Land
V. Climate
VI. Economy
A. Natural Resources
B. Manufacturing
C. Agriculture
D. Mining
E. Foreign Trade
F. Transportation
G. Communication
VII. History

Questions

Who founded Sweden's present royal family?
What is the principal religion of Sweden?
How did Sweden get its name?
Why did many Swedes emigrate in the late 1800's?
What are Sweden's three chief natural resources?
What are Sweden's two largest lakes and islands?
Who was the first Swedish writer to win world fame?
Why are Sweden's forests important to its economy?
What are some of the welfare benefits in Sweden?
What is smörgåsbord?

Brown Bros.
Emanuel Swedenborg

SWEDENBORG, *SWEE duhn bawrg*, or, in Swedish, *SVAY duhn BAWR y*, **EMANUEL** (1688-1772), was a Swedish scientist, inventor, and mystical religious leader. He became an authority on mathematics, astronomy, metallurgy, anatomy, and geology, and was named a member of the Swedish State Council of Mines. He is credited with a number of inventions, and drew plans for a submarine, an airship, and a magazine-type gun, all forerunners of those of today.

Swedenborg, son of a bishop and nobleman, was born in Stockholm. He turned to religion in middle age, although he retained his scientific interests. He wrote a number of books setting forth what he called his "heavenly doctrines." He claimed that they were based on Bible teachings which had been interpreted to him through direct communication with the spiritual world. His views brought him much criticism.

Swedenborg did not intend to found a separate religious body, but, soon after his death in London, some of his followers began to form churches founded on his views. They became known as the Church of the New Jerusalem. F. A. NORWOOD

See also SWEDENBORGIANS.

SWEDENBORGIANS, *SWEE duhn BAWR jee uhns*, look to the formulation of Christian doctrine as set forth by Emanuel Swedenborg, a Swedish theologian. A church based on this doctrine was organized in London in 1787, and in the United States in 1792. Churches in the United States and Canada set up the General Convention of the New Jerusalem in 1817. A separate body, formed in 1890, took the name General Church of the New Jerusalem. Swedenborgians have societies and missions in many parts of the world, usually affiliated with the American bodies or with the Conference of the New Church in Great Britain.

Swedenborg's teachings emphasize one God, the Lord and Savior Jesus Christ, in whom is the Trinity: Father, Son, and Holy Spirit. Swedenborgians believe that the Holy City, New Jerusalem, is symbolic of an ideal human society. They regard Jesus as truly *Immanuel*, or *God with us*. They believe that Swedenborg was called by God to reveal deeper spiritual meanings in scripture, and that, when mankind accepts and practices these truths, Jesus Christ makes his second coming in spirit, not in person. DAVID P. JOHNSON

SWEDISH NIGHTINGALE. See LIND, JENNY.

SWEEPER. See VACUUM CLEANER; CARPET SWEEPER.

SWEEPSTAKES. See HORSE RACING (Types of Races); LOTTERY.

SWEET ADELINES, INC. See BARBERSHOP QUARTET SINGING.

SWEET ALYSSUM, *uh LIHS uhm*, is a low, spreading plant with clusters of tiny lavender or white flowers. It is a hardy plant that gardeners can sow in early spring. Sweet alyssum usually blooms within six weeks after planting. Some varieties are dwarfed, and others grow about 9 inches (23 centimeters) high.

Scientific Classification. Sweet alyssum belongs to the mustard family, *Cruciferae*. It is classified as genus *Lobularia*, species *L. maritima*. ROBERT W. SCHERY

SWEET BRIAR COLLEGE is a liberal arts college for women at Sweet Briar, Va. It offers courses leading to the A.B. degree. Sweet Briar administers the Junior Year in France, a foreign study program for men and women.

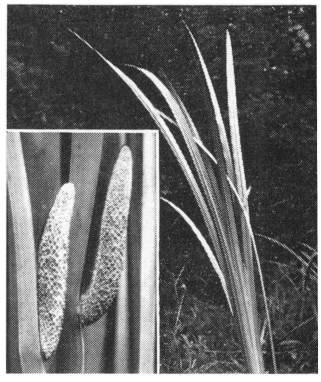
The college was chartered in 1901, and opened in 1906. For enrollment, see UNIVERSITIES AND COLLEGES (table).

SWEET CHERVIL. See CICELY.

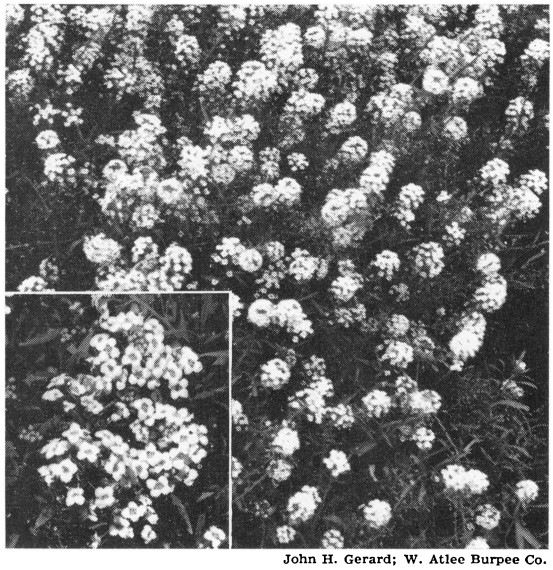
SWEET CORN. See CORN.

SWEET FLAG is a tall reedlike plant of the arum family. It grows along brooks and in marshy places in almost all parts of the Northern Hemisphere. Its leaves are flat and 2 to 6 feet (61 to 180 centimeters) long. They are shaped like a two-edged sword. The stems of the sweet flag are almost like the leaves, but are stiffer and bear spikes of small green blossoms near the top. The leaves and stems rise directly from the thick, fleshy underground rootstock. The rootstock is the calamus root. It is used as a tonic and in the manufacture of perfume and other toilet preparations. In Europe, the rootstock is valued as a food.

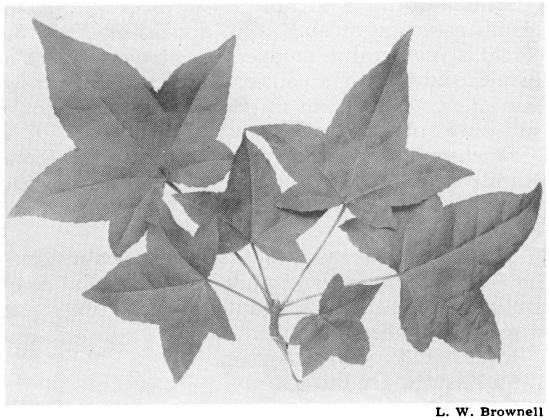
Sweet Flag, a useful herb, has small flower spikes, *inset*.
L. W. Brownell; Carl L. Howard



Scientific Classification. The sweet flag is in the arum family, *Araceae*. It is genus *Acorus*, species *A. calamus*. HAROLD NORMAN MOLDENKE



John H. Gerard; W. Atlee Burpee Co.
Sweet Alyssum produces clusters of tiny white flowers, *inset*. A low plant, it has long been popular for garden borders.



L. W. Brownell

Leaves of the Sweet Gum, or Red Gum, are among the most brilliant in autumn. The tree is tall and stately.

SWEET GUM, also called RED GUM, is a tall, stately tree. It grows from Connecticut and southern New York to Florida and westward to southern Illinois, Oklahoma, and eastern Texas. Normally, it reaches a height of 80 to 100 feet (24 to 30 meters). When mature, its straight trunk is 3 to 4 feet (91 to 120 centimeters) thick at the base. Sweet gum leaves are deeply lobed, and turn a deep crimson in autumn. The fruit is a brownish, spiny ball that remains on the tree through the winter. The sweet gum is so named because it produces a gummy compound, called *storax*, that is used in making perfumes, adhesives, and salves. Sweet gum wood is fairly hard and heavy. People use it to make veneer, cabinets, and other products.

Scientific Classification. Sweet gum trees belong to the witch hazel family, *Hamamelidaceae*. They are genus *Liquidambar*, species *L. styraciflua*. T. EWALD MAKI

SWEET PEA is a favorite garden flower that belongs to the same family as the kind of pea that we eat. People grow the sweet pea for the beauty and fragrance of its flowers. The sweet pea is one of the special flowers for the month of April. Sweet pea flowers are blue, red, pink, purple, and white. Some look like butterflies. There are more than 1,000 varieties of sweet pea. In some, the flower petals are smooth and velvety. In others, they are crinkled and wavy. The plants may be *dwarf*, which grow close to the ground, or *climbing*, which grow along strings or trellises.

Rich, well-drained soil, plenty of sunshine, and free circulation of air are needed to raise sweet peas. Gardeners should sow the seed in April. They use 1 ounce (28 grams) of seed to 30 feet (9 meters) of row. The plants should be at least 2 inches (5 centimeters) apart in the row, and the rows should be 4 feet (1.2 meters) apart. As soon as the plants appear above ground, the gardener should cultivate the ground. He should stir the soil lightly every week, preferably after a rain, and keep the rows free of weeds. Once a week he should feed the plants with a liquid fertilizer.

The vines should be trained on strings. Wire trellises may absorb too much heat. The flowers should be picked as they open, before they go to seed.

Scientific Classification. Sweet peas belong to the pea family, *Leguminosae*. Common garden sweet peas are genus *Lathyrus*, species *L. odoratus*. DONALD WYMAN

SWEET POTATO is a vegetable of the morning-glory family of plants. Its large, fleshy roots are a popular food. Sweet potatoes are often called *yams*, but yams belong to another family and grow mostly in the tropics.

Sweet potatoes may be yellow or white. Yellow sweet potatoes are grown chiefly in the southern United States. The varieties called *Yellow Jersey* and *Triumph* are dry. *Porto Rico* and *Centennial* sweet potatoes are moist. Most white sweet potatoes come from Africa or Asia. Some kinds of sweet potato plants have pale green vines with small, pointed leaves. Other types have purple vines with large leaves. Sweet potato vines grow from the main stem and lie along the ground.

Sweet potatoes have high energy value and contain vitamins A and C. They may be bought fresh, canned, or *dehydrated* (dried by removing the water). Sweet potatoes first grew in tropical regions of the Western Hemisphere and were raised in colonial Virginia during the early 1600's. They are sometimes used in making alcohol and starch. The American scientist George Washington Carver made 118 products from sweet potatoes (see CARVER, GEORGE WASHINGTON).

Sweet potato plants are grown from roots placed in moist, warm, sandy soil in greenhouses or hotbeds about four weeks before planting time. Stem buds from the roots produce new plants called *slips* that push up through the soil. They are removed and planted 1 foot (30 centimeters) apart in rows 3 to 4 feet (91 to 120 centimeters) apart. The rows are usually ridged to help the water drain. Some hoeing or treatment with weed control chemicals helps the slips grow.

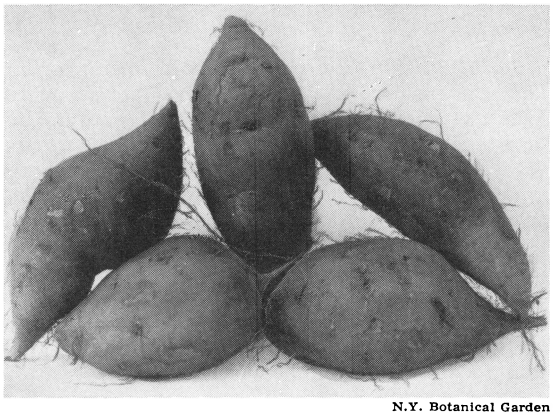
Crops of sweet potatoes should be harvested before frost occurs. The roots must be handled carefully to pre-

LEADING SWEET POTATO GROWING STATES

Bags of sweet potatoes grown in 1973*

North Carolina	3,625,000 bags
Louisiana	2,970,000 bags
Virginia	1,073,000 bags
Mississippi	1,045,000 bags
California	864,000 bags
Texas	760,000 bags
Georgia	600,000 bags
Alabama	383,000 bags
Tennessee	320,000 bags
Maryland	294,000 bags

*One bag equals 100 pounds (43 kilograms).
Source: *Crop Production 1973 Annual Summary*, U.S. Department of Agriculture.



N.Y. Botanical Garden

The Toothsome Sweet Potato has long been associated with holiday feasts. It has great commercial importance.

vent bruising. They are *cured* (dried) in buildings at temperatures from 80° to 90° F. (27° to 32° C) and then are stored at temperatures of 55° to 60° F. (13° to 16° C).

Sweet potatoes may be affected by diseases caused by tiny plants called *fungi* (see FUNGI). The fungi can be controlled by using disease-free seed, by treating the seeds with chemicals, or by crop rotation.

Scientific Classification. The sweet potato belongs to the morning-glory family, *Convolvulaceae*. It is genus *Ipomoea*, species *I. batatas*. TEME P. HERNANDEZ

See also YAM.

SWEET WILLIAM is a popular garden plant that is native to northern Europe and Asia and to the United States. The plant usually grows about 2 feet (61 centimeters) high and bears dense, round clusters of velvety flowers. The flowers range in color from white to pink, rose, or purple. Some are red with white spots. Cultivated plants may bear double flowers. Gardeners usually cultivate sweet William as a *biennial* (a plant that requires two years to mature).

Scientific Classification. Sweet William is in the pink family, *Caryophyllaceae*. It is genus *Dianthus*, species *barbatus*. H. D. HARRINGTON

Sweet William Blossoms form large velvety clusters at the end of the stem. One cluster may have flowers in many shades.

J. Horace McFarland

SWEETBREAD is a tasty meat that comes from certain glands in young animals. The thymus gland in the throat of young calves produces sweetbread that is sold in fine restaurants. The pancreas of older calves is called *stomach sweetbread* or *belly sweetbread*. It is much like the sweetbread of the thymus gland.

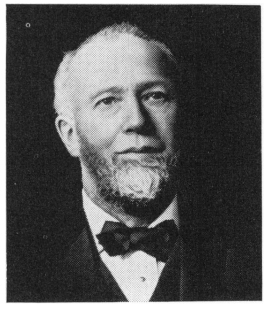
Butchers divide the thymus gland into the throat sweetbread and the heart, or breast, sweetbread. Heart sweetbread is larger and more tender than throat sweetbread.

The best sweetbread is that taken from baby calves, because the thymus gland gradually shrinks and disappears after the animal grows older. Lamb sweetbread is too small to be sold in markets. JOHN C. AYRES

SWEETBRIER. See EGLANTINE.

SWELLFISH. See PUFFER.

SWIFT is the name of a family that developed one of the world's leading meat-packing companies. Two generations of that family guided the company from a small New England firm to world leadership in the industry.



Gustavus Swift

Gustavus Franklin Swift (1839-1903) started working for his brother, a butcher, at 14, and went in business for himself at the age of 17. Before he was 35, he was a cattle exporter and a wholesale meat dealer. Association with the meat business from 1855 until his death made him an expert judge of cattle.

Swift saw the need to eliminate excessive transportation costs. In 1875 he went to Chicago and became the first to slaughter meat there for shipment east. At first this activity had to be confined to the cooler months, but the use of the refrigerator car made it a year-round business.

On April 1, 1885, Swift & Company was formed. Because of the continuous growth of Swift's company in an expanding industry, he had to use unusual methods in raising additional capital. He became famous for his emphasis on cost-cutting and his insistence on the full use of by-products. He was born in Cape Cod, Mass.

Louis Franklin Swift (1861-1937), the oldest son of Gustavus Franklin Swift, became president of Swift & Company when his father died, and served until 1931. Later he served as chairman of the board of directors. Under his leadership, the company established a pension trust and made other advances in labor relations. Swift was active in company expansion plans, opening plants in the United States, and in South America, Australia, and New Zealand. These foreign operations were separated from Swift & Company in 1918, and became Compania Swift Internacional. Louis Swift was born in Sagamore, Mass.

Edward Foster Swift (1863-1932), the second son of Gustavus Franklin Swift, worked closely with his older brother in formulating company policies. He served as vice-president of the company and as president of Compania Swift Internacional and other company affiliates. He was born in Barnstable, Mass.

Charles Henry Swift (1872-1948), the fourth son of Gustavus, succeeded Louis Franklin Swift as chairman of the board of directors of Swift & Company in 1932. He encouraged the branch-house system of distribution, which increased the efficiency of the company's marketing system. He was born at Lancaster, Mass.

Gustavus Franklin Swift, Jr. (1881-1943), the seventh son of Gustavus Franklin Swift, became president of Swift & Company in 1931, and served until 1937. He took a leading part in the organization of the American Meat Institute. He was born in Chicago, Ill.

Harold Higgins Swift (1885-1962), the youngest son of Gustavus Franklin Swift, served as vice-president in charge of industrial relations. He became chairman of the board in 1948 and honorary chairman in 1955. He became a member of the University of Chicago board of trustees in 1914, and served as its chairman from 1922 to 1949. He was a director of the Rockefeller Foundation. He was born in Chicago. W. H. BAUGHN

SWIFT is a small bird that can fly for many hours with its long, strong wings. Swifts capture their insect food while flying. They almost always return at dusk to the cave, chimney, cliff, or hollow tree where they live in flocks. A chimney swift may fly 135,000 miles (217,000 kilometers) a year. Swifts build nests made of sticks that they cement together with their saliva. Some nests are almost entirely made up of saliva. They resemble the bird's nests of east Asia that people eat.

More than 75 different kinds of swifts live in various parts of the world. They are sooty-brown or greenish-black. Some swifts have white throats or rumps. Their song, continually repeated, is little more than short, indistinct sounds.

The chimney swift of eastern North America almost always builds its nest in chimneys. Vaux's swifts of western North America and chimney swifts may roost by the thousands in large chimneys while migrating. They perform spectacular maneuvers in the air as they descend into the chimneys for the night.

Scientific Classification. Swifts make up the swift family, *Apodidae*. The chimney swift is genus *Chaetura*, species *C. pelagica*. Vaux's swift is *C. vauxi*. LEONARD W. WING

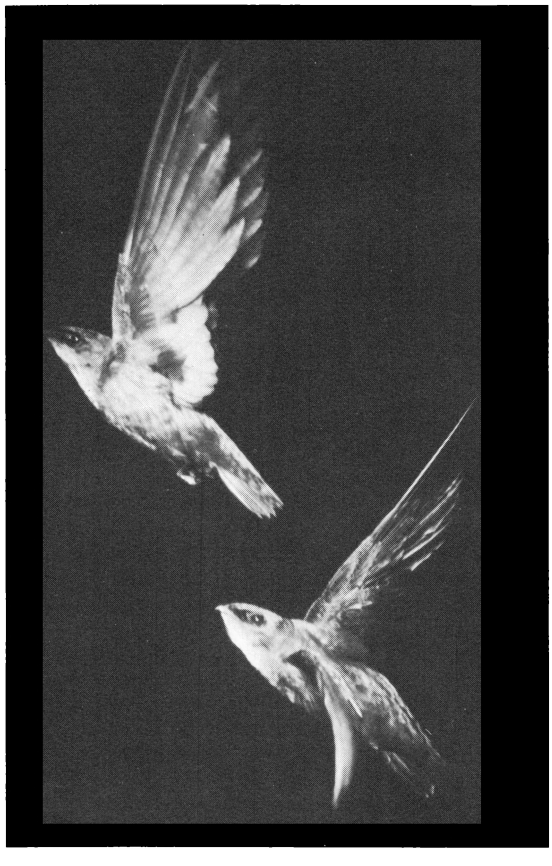
See also ANIMAL (color picture: Animals of the Mountains [Nepalese Swift]); BIRD (Building the Nest; Interesting Facts About Birds [Fastest Flier]); BIRD'S-NEST SOUP.

SWIFT is the name of certain small lizards that are unusually active. Swifts live on dry land in the western part of North America and in Central America. These lizards have tiny scales with sharp points that often look like spines. There are about 50 different kinds of swifts.

Scientific Classification. Swifts belong to the New World lizard family, *Iguanidae*. They are classified in the genus *Uta* and in the genus *Sceloporus*. CLIFFORD H. POPE

See also LIZARD.

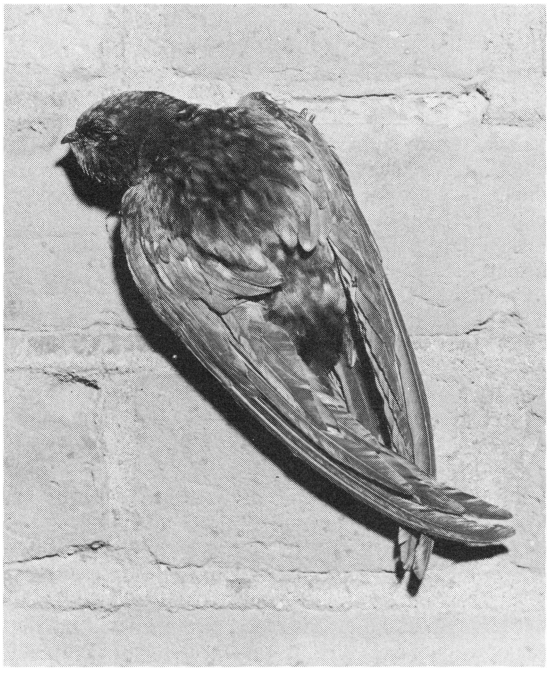
Treat Davidson, NAS



Swifts Are Strong, Fast Fliers. Some of them can travel over 100 miles (160 kilometers) per hour for short distances. They feed on insects while in the air. Some swifts spend the night in flight.

Swifts Usually Roost on Vertical Surfaces, clinging with sharp toenails and using the tail as a prop, *below*. They rarely perch on branches because their feet and legs are small and weak.

Eric Hosking, Photo Researchers



SWIFT, JONATHAN (1667-1745), an English author, wrote the story *Gulliver's Travels* (1726), a masterpiece of literature. Swift is called a great *satirist* because of his ability to ridicule customs, ideas, and habits he considered silly or harmful. His satire is often bitter, but it is also often humorous. Swift was deeply concerned about the welfare and about the behavior of his fellow men, and he used his talent to strike out against those men, institutions, and ideas that he considered foolish.

Jonathan Swift by Charles Jervas. National Portrait Gallery, London

Jonathan Swift

Swift's life was interesting and useful. Swift was a Protestant preacher who became a hero in Roman Catholic Ireland. He wrote many pamphlets to protest the sufferings of the Irish under their British rulers. He was also a friend of important English statesmen and a writer on English political issues.

His Life. Swift was born in Dublin on Nov. 30, 1667. His parents were of English birth. Swift was graduated from Trinity College in Dublin, and moved to England in 1689. He was secretary to the distinguished statesman Sir William Temple from 1689 until 1699, with some interruptions. In 1694, Swift became a minister in the Church of England.

While working for Temple, Swift met a young girl named Esther Johnson, whom he called Stella. He and Stella became lifelong friends, and some persons believe they were married. There is no proof of their marriage, however. Swift wrote long letters to Stella during his busiest days. The letters were published after Swift's death as the *Journal to Stella*.

After Temple died in 1699, Swift became pastor of a small Protestant parish in Laracor, Ireland. He began to play an important part in church life, and his skill as a writer became widely known. He visited England often between 1703 and 1710, conducting church business and winning influential friends. In 1710, he became a powerful supporter of the new Tory government in England. Through his many articles and pamphlets in defense of Tory policies, Swift became one of the most effective public relations men any English administration has ever had.

Queen Anne recognized Swift's political work in 1713 when she made him *dean* (head clergyman) of St. Patrick's Cathedral in Dublin. The queen died in 1714, and George I became king. The Whig Party won control of the government that year. These changes ended the political power of Swift and his friends.

Swift spent the rest of his life—more than 30 years—as dean of St. Patrick's. In many ways, these years were disappointing. Swift was unhappy because his political efforts had amounted to so little. He also missed his exciting friends in England. But it was as dean that Swift wrote *Gulliver's Travels* and that he became the champion of the Irish cause.

Swift's health declined in his last years and finally his mind failed. He died on Oct. 19, 1745. He left his money to start a hospital for the mentally ill.

Gulliver's Travels is often described as a book children read with delight, but which adults find serious and disturbing. However, even young readers usually recognize that Swift's "make-believe" world sometimes resembles their own world. Adults recognize that, in spite of the book's seriousness, it is also amusing.

Gulliver's Travels describes four voyages that Lemuel Gulliver, who was trained as a ship's doctor, makes to strange lands. Gulliver first visits the *Lilliputians* (pronounced *lil eh PEW shuns*)—tiny people whose size and surroundings are only $\frac{1}{12}$ those of normal people and things. The Lilliputians treat Gulliver well at first. Gulliver helps them, but after a time the Lilliputians turn against him and he is happy to escape from them.

Gulliver's second voyage takes him to the country of *Brobdingnag* (pronounced *BROB ding nag*), where the people are 12 times larger than Gulliver and greatly amused by his puny size.

Gulliver's third voyage takes him to several strange kingdoms. The conduct of the odd people of these countries represents the kinds of foolishness Swift saw in his world. For example, in the academy of Lagado, scholars spend all their time on useless projects such as getting sunbeams from cucumbers. Here Swift was satirizing impractical scientists and philosophers.

In his last voyage, Gulliver discovers a land ruled by wise and gentle horses called *Houyhnhnms* (pronounced *HWIN ems*). Savage, stupid animals called *Yahoos* also live there. The Yahoos look like human beings. The Houyhnhnms distrust Gulliver because he resembles the Yahoos. Gulliver wishes to stay in the agreeable company of the Houyhnhnms, but they force him to leave.

Some persons believe Swift was a *misanthrope* (hater of mankind), and that the ugliness and stupidity in his book reflect his view of the world. Other persons argue that Swift was a devoted and courageous Christian who could not have held such bitter opinions about his fellow man. Some of them claim that in *Gulliver's Travels*, Swift is really urging us to avoid the extremes between the boringly perfect Houyhnhnms and wild Yahoos and to lead moderate, sensible lives.

Scholars are still trying to discover all the ways in which real persons, institutions, and events are represented in *Gulliver's Travels*. But readers need not be scholars to find pleasure in the book and to find themselves set to thinking about its distinctive picture of human life.

Swift's Other Works. "A Modest Proposal" (1729) is probably Swift's second best-known work. In this short essay, Swift pretends to urge that Irish babies be killed and eaten. They would be as well off, says Swift bitterly, as those Irish who grow up in poverty under British rule. Swift hoped this outrageous suggestion would shock the Irish people into taking sensible steps to improve their condition.

A Tale of a Tub (1704), on the surface, is a story of three brothers arguing over their father's last will. But it is actually a clever attack on certain religious beliefs and on man's false pride in his knowledge.

In *The Battle of the Books* (1704), a lighter work, Swift imagines old and new books in a library waging war on each other. This work reflected a real quarrel

Engraving by Bernard Lens the elder for the 1710 edition of *The Battle of the Books*. Newberry Library, Chicago

The Battle of the Books **ridicules scholars who argued the relative merits of ancient and modern writers. This picture shows a battle between ancient and modern books in a library.**

between scholars who were proud of being "modern," and scholars who believed the wisdom of the ancient thinkers could not be bettered.

Swift wrote many pamphlets in support of his political views. *The Drapier's Letters* (1724) are probably the most notable. Swift, in the character of a dry-goods merchant, urged the Irish to boycott the use of copper money, which England tried to force on them.

Swift could also be very playful. He loved riddles, jokes, and hoaxes. One of his best literary pranks was the so-called *Bickerstaff Papers* (1708). In this work, he ridiculed a popular astrologer and almanac writer by publishing his own wildly improbable predictions.

Swift wrote a great deal of poetry and light verse. Much of his poetry is humorous, and it is often sharply satirical as well. But many of his poems, both comic and serious, show his love for his friends.

Swift's Personality. Whether Swift hated mankind or whether he mocked men to reform them is still disputed. However, there are some things Swift clearly hated and loved.

Gulliver's Travels **is Swift's most famous book. In its best-known episode, Gulliver is shipwrecked in the country of Lilliput where the people are only 1/12 his size. He awakes to find that the Lilliputians have tied him down with hundreds of tiny ropes.**

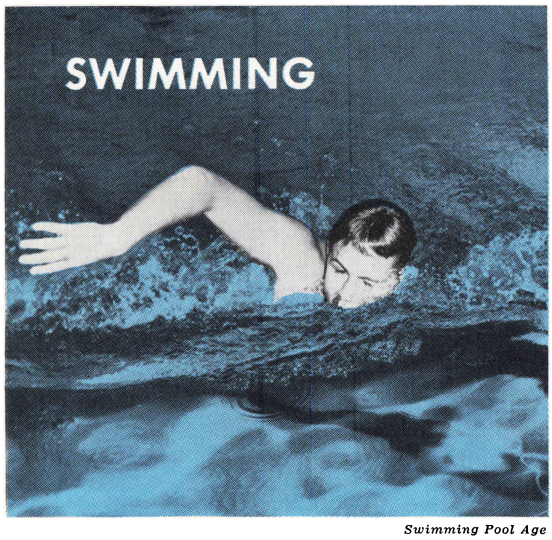
He hated those who attacked religion, particularly when they pretended to be religious themselves. He also hated the tyranny of one nation over another nation. Above all, he hated false pride—the tendency of men to exaggerate their own accomplishments and overlook their own weaknesses. Swift loved his religious faith. He also loved liberty, simplicity, honesty, and humility. His writings—whether bitter, shocking, or humorous—ask the reader to pursue these virtues.

Critically reviewed by EDWARD ROSENHEIM, JR.

SWIGERT, JOHN LEONARD, JR. (1931-), a United States astronaut, served as command module pilot of the Apollo 13 lunar flight in April, 1970. A member of the flight's backup crew, Swigert replaced Thomas K. Mattingly, who had been exposed to German measles. Swigert made the flight with astronauts Fred W. Haise, Jr., and James A. Lovell, Jr.

About 56 hours after the flight began, an explosion caused by a short circuit destroyed the command module's life support and electrical systems. The crew switched to the lunar module's systems and used them to return to the earth. People in all parts of the world waited during the tense return trip that ended safely nearly four days later.

Swigert was born in Denver, Colo., on Aug. 30, 1931. He served in the Air Force from 1953 to 1956. Swigert then worked as a civilian test pilot until 1966, when he became an astronaut. WILLIAM J. CROMIE



Swimming Pool Age

SWIMMING is one of the most popular and healthful sports. Every year, millions of persons enjoy swimming in oceans, lakes, and rivers in all parts of the world. Indoor pools in schools and recreation centers make swimming a year-round sport. Swimming uses most of the body's muscles, and develops grace and strength.

Swimming ranks as one of man's oldest sports. Cave drawings made in the Libyan Desert about 11,000 years ago show people swimming. An Egyptian nobleman who lived about 2160 B.C. recorded that his children took swimming lessons. About 880 B.C., Assyrian warriors used a crawl-type stroke to swim across streams.

Organized swimming contests began in Great Britain during the 1880's. In the United States, athletic clubs first held swimming meets in the early 1900's. Today, thousands of swimmers compete in meets held by high schools, colleges, and swimming clubs throughout the United States, Canada, and other countries. Long-distance swimmers often attempt such feats as swimming the English Channel or one of the Great Lakes.

How to Swim

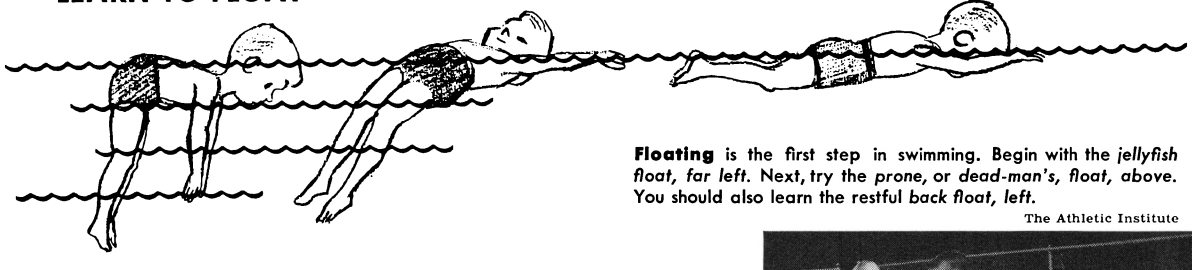
The ability to swim does not come naturally to man, as it does to fishes, frogs, and many other animals. People must learn to swim. The best and safest way to learn is under the guidance of a trained instructor. No swimmer, skilled or unskilled, should ever swim alone. An adult swimmer or lifesaver who can help in an emergency should always be present.

Entering the Water. Swimming lessons should start at a pool or beach protected by lifeguards. The beginner, with his instructor, enters the water gradually. He splashes himself gently, and finally goes into the water up to his neck. Bobbing in shallow water can help teach the proper way to breathe while swimming. To bob, the beginner takes a deep breath through his mouth when his head is above water, and breathes out through his mouth and nose under water. The use of swimming aids such as life jackets can also help develop a beginner's confidence in the water.

Floating is the next step in learning how to swim. The beginner starts with the *jellyfish float*. From a standing position in waist-deep water, he takes a deep breath and bends at the waist until his head and the upper part of his body are in the water. At the same time, he moves his hands from his waist, down along his legs, to his ankles and feet. When this is done, his feet automatically lift off the ground and he finds himself floating.

Next, the student learns the *prone float*, or *dead-man's float*. He takes a deep breath and puts his face in the water. Then he stretches his legs as far backward as possible and extends his arms forward beyond his head. To do the *prone glide*, or *moving dead-man's float*, he (1) leans forward with his arms extended over his head, and hands together; (2) lowers his shoulders below the surface of the water; (3) takes a deep breath; (4) puts his

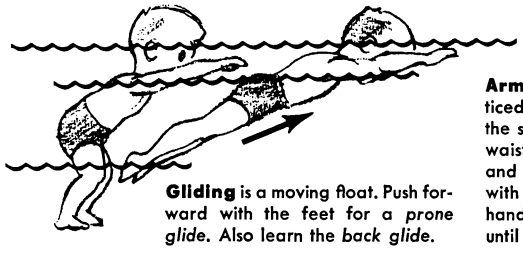
LEARN TO FLOAT



Floating is the first step in swimming. Begin with the *jellyfish float, far left.* Next, try the *prone,* or *dead-man's, float, above.* You should also learn the restful *back float, left.*

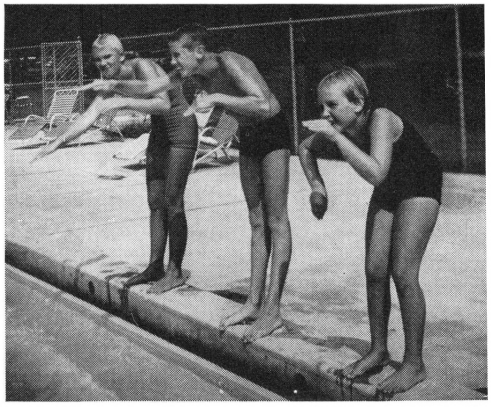
The Athletic Institute

THEN TO GLIDE AND STROKE



Gliding is a moving float. Push forward with the feet for a *prone glide.* Also learn the *back glide.*

Arm Strokes can be practiced easily while standing on the side of a pool, *right,* or in waist-deep water. Bend over, and reach alternately forward with each hand. Press each hand straight down and back until it points downward.



face in the water; and (5) pushes forward with his feet. To stand up, he pulls his knees under his body, pushes his hands down, and lifts his head.

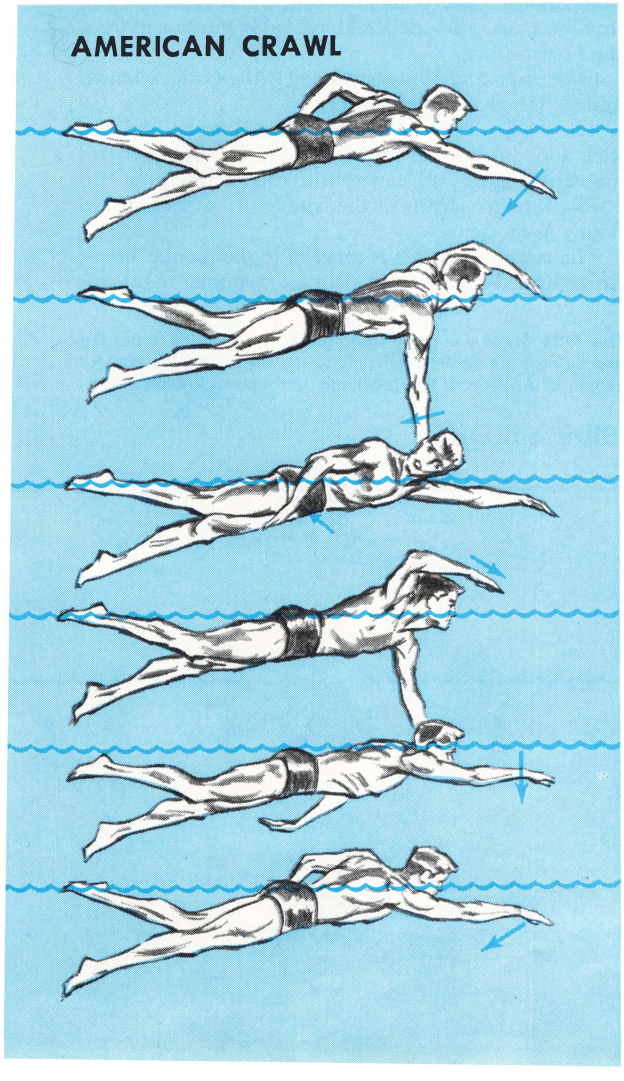
The beginner must also learn the *back float* and *back glide*. These provide restful positions in the water and allow easy breathing, because the face is above water. To float on his back, the student squats in a sitting position in waist-deep water. His shoulders should be below the surface of the water. Next, he stretches his hands sideward with the palms up under the water, tilts his head back, and looks straight up. Then he lifts his hips as close to the surface as possible. His legs should be extended and relaxed. The beginner can do the back glide by pushing backward with his feet from the squatting position. To stand up, he pulls his knees up, moves his hands forward, and bends his head down.

Kicking is the next step in learning to swim. The student can practice kicking by first holding onto the side of a pool or by floating in shallow water with his hands on the bottom. He thrashes his legs up and down in whiplike movements. The legs should be moved only far enough to feel the knees pass each other. The knees should bend slightly, and the ankles should be relaxed with the feet *pigeon-toed*, or turned in. The power in the kick comes from the hips.

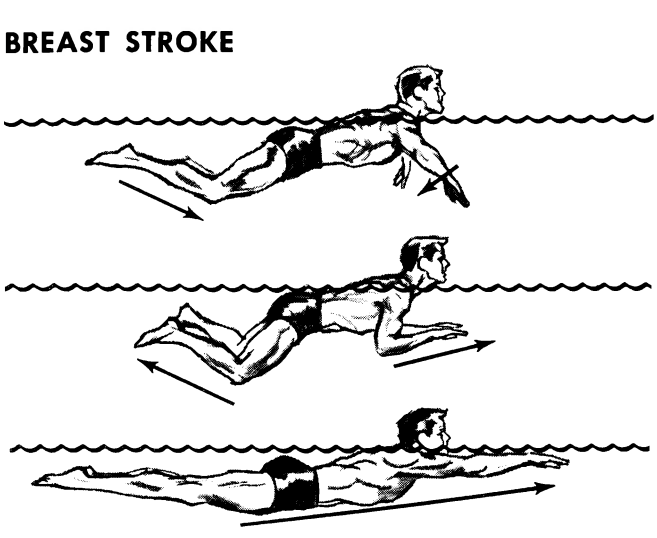
After the beginner masters the kick, he should combine it with the prone glide to propel himself through the water. He should also practice a similar kick on his back, and combine it with the back glide.

The Arm Stroke. After learning to float and kick, the beginner is ready for the *dog paddle* or *human stroke*. The student does this stroke from the prone glide and moves his arms in much the same way that a dog moves its legs in swimming. He reaches forward first with one arm and then the other, and presses each arm in turn straight down and back until it points downward from his shoulder. One arm should be going forward while the other is going down and back. The hands should be relaxed, with the fingers slightly separated. The beginner can get the feel of this arm stroke by walking bent over while stroking under water. Finally, he combines the arm stroke with the prone glide and kick.

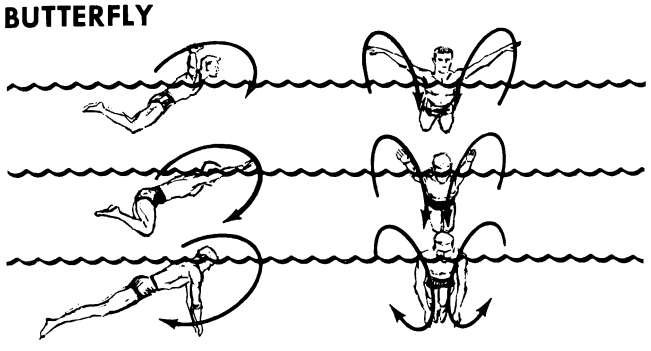
The American Crawl is the fastest stroke. It combines a hand-over-hand arm stroke with a flutter kick, the feet lashing upward and backward. All breathing is done on the same side.



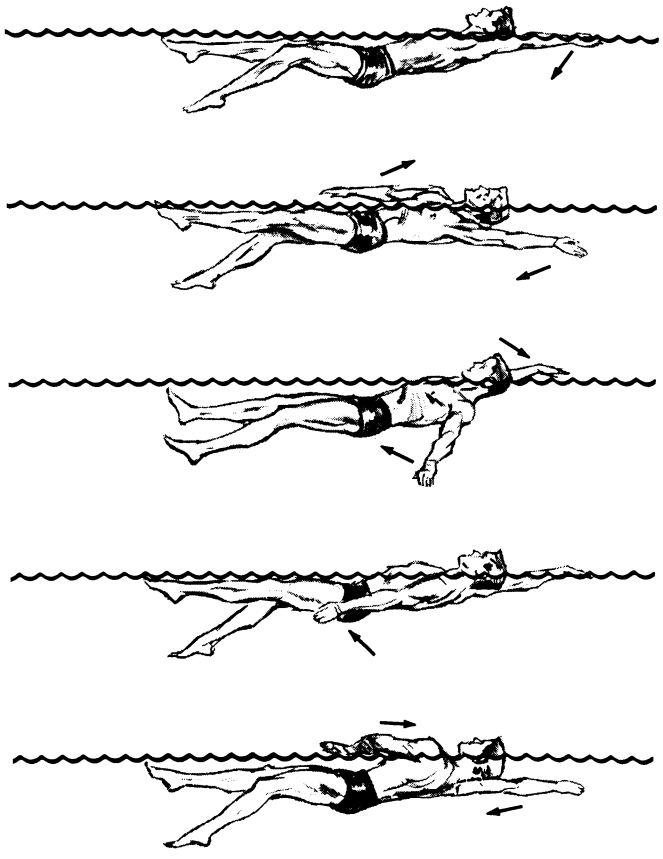
The Breast Stroke is one of the most restful strokes. Extend the arms forward, then sweep them out and back, drawing up the legs, knees out. Sweep legs together as arms go forward again.



The Butterfly is a racing stroke. Lift both arms from the water, then lash them down and back to the waist. Use a *dolphin kick*, flutter-kicking both legs up and down at the same time.



BACKSTROKE



The Backstroke is much like the crawl turned upside down. The swimmer uses a flutter kick, and alternately stretches each arm straight back, then pulls it in a straight line to his hips.

Rhythmic Breathing must be learned to complete the dog paddle. This can be practiced by standing in chest-deep water or by kneeling in shallow water. The beginner starts the dog-paddle arm stroke, then takes a deep breath and puts his face in the water. He breathes out into the water through his mouth and nose as his left hand slides forward. Then he turns his face out of the water to the left side and breathes in through his mouth as his right hand slides forward. Some persons find it easier to turn the head to the right and inhale as the left hand slides forward.

After the student has learned to coordinate his arm strokes and breathing, he is ready to try the complete dog paddle. First, he does the prone glide and kick. Next, he adds the arm stroke, and then he starts rhythmic breathing. When the beginner can swim 25 yards (23 meters) with the dog paddle, he has a good foundation for learning the standard swimming strokes.

Swimming Strokes. There are five basic swimming strokes: (1) the American crawl, or free style; (2) the breast stroke; (3) the butterfly stroke; (4) the backstroke; and (5) the side stroke.

The American Crawl, or *Free Style*, is the fastest stroke. It combines a *flutter kick*, each foot lashing backward and upward, with a hand-over-hand arm stroke and rhythmic breathing. The American crawl developed from a racing stroke introduced about 1900 by Richard Cavill, an Australian swimmer.

The Breast Stroke is one of the most restful strokes. The swimmer extends his arms, then sweeps them out and back so that the palms press against the water. He draws up his legs with the knees thrust sideways. Then he pushes his legs out and sweeps them together as he extends his arms forward again. Swimmers have used the breast stroke since at least the 1500's.

The Butterfly Stroke is a racing stroke. The swimmer lifts both arms forward out of the water, then lashes them back toward his waist. Many swimmers use a *dolphin kick* with the butterfly. This is a double flutter kick. Both legs are whipped up and down together. The regular breast-stroke kick is also used. Jack Sieg, a University of Iowa swimmer, developed the butterfly stroke in 1935.

The Backstroke is much like the crawl turned upside down. It combines a flutter kick with a hand-over-hand arm stroke. This stroke originated as a stunt stroke about 1902.

The Side Stroke is a restful stroke and is not used for racing. The swimmer does a scissors kick. He floats on one side, draws up his upper leg, thrusts it forward and out, then snaps his legs together. As the swimmer snaps his legs together, he extends his lower hand forward from his chin and pulls his upper hand straight back from his chin. The side stroke probably developed from the breast stroke.

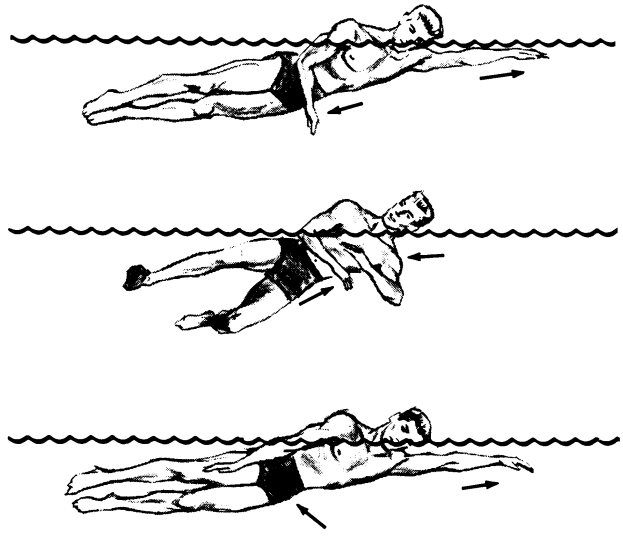
Other Important Strokes include (1) the trudgen crawl, and (2) the victory backstroke.

The *trudgen crawl* is a regular crawl with a scissors kick added at regular intervals. J. Arthur Trudgen, an amateur English swimmer, introduced this crawl in 1873. Trudgen learned the stroke from Indians in South America.

The *victory backstroke* is much like the regular breast stroke turned upside down. But the swimmer moves his

The Side Stroke uses the scissors kick. Draw up the upper leg and thrust it out. Move the hands to the chin. Snap the legs together, and pull back the upper arm and extend the lower arm.

SIDE STROKE



arms and legs at the same time, rather than alternately as in the breast stroke. This stroke always keeps the swimmer's face out of the water. It received its name because it was taught to United States servicemen during World War II.

Swimming as a Sport

Swimming Meets. The Amateur Athletic Union (AAU) establishes the rules for swimming meets in the United States. It recognizes records for races ranging from 50 yards to 4 miles, and from 100 to 1,500 meters. Free-style (crawl) races are held at all these distances. (A *free-style race* can also be a contest in which the swimmers use any stroke or strokes they desire.) Backstroke, breast stroke, butterfly, relay, and medley races cover only certain distances. In an *individual medley* race, each swimmer must use three or four different strokes—butterfly, backstroke, breast stroke, and crawl. The breast stroke is used only in four-stroke relay races. In a *medley-relay* race, each member of the four-man relay team swims a different stroke. See AMATEUR ATHLETIC UNION OF THE UNITED STATES.

In Canada, the Canadian Amateur Swimming Association establishes the rules for meets. The International Amateur Swimming Federation sets the rules for recognizing world swimming records. See the *World Swimming Records* table with this article. For Olympic records, see OLYMPIC GAMES (table: Swimming).

Water Ballet, or *synchronized swimming*, is especially popular with women. One or more swimmers glide through graceful formations, often accompanied by music. The swimmers "dance" in water much as ballerinas dance on a stage. They often perform the same strokes and formations at the same time. Many high schools and colleges in the United States and Canada have water-ballet groups. Judges of ballet contests award points under a scoring system similar to that used in diving (see DIVING [Competitive Diving]).

Famous Swimmers

Chadwick, Florence (1918-), became the first woman to swim the English Channel in both directions. She swam from France to Great Britain in 1950, and from Britain to France in 1951. In 1952, she became the first woman to swim the 21 miles (34 kilometers) from Catalina Island to the mainland of California. Miss Chadwick also conquered the Strait of Gibraltar, the Bosporus, and the Dardanelles. She was born in San Diego, Calif.

Crabbe, Buster, (1908-), won fame as a world-champion swimmer and motion-picture and television star. Crabbe won the 400-meter free-style race in the 1932 Olympic Games. He was the first Olympic champion to swim this race in less than five minutes. Crabbe set five world records during his swimming career. Clarence Crabbe was born in Oakland, Calif.

Ederle, Gertrude, was the first woman to swim the English Channel. See EDERLE, GERTRUDE CAROLINE.

Geraghty, Agnes (1907-), ranked as one of the greatest woman breast-stroke swimmers in the United States during the 1920's. Miss Geraghty held the 200-yard indoor breast-stroke title in 1924 and 1925, and the 100-yard indoor breast-stroke crown in 1926 and 1927. She was born in New York City.

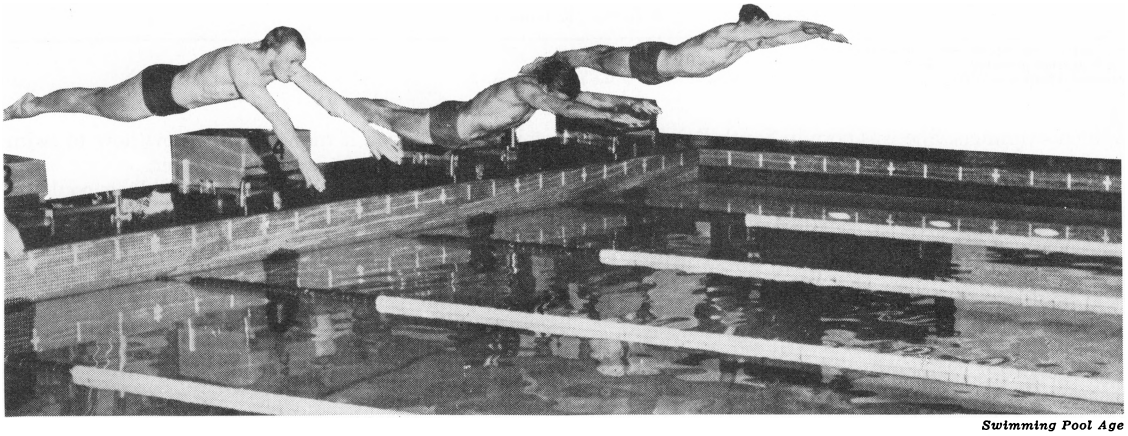
Holm, Eleanor (1913-), won fame as a backstroke swimmer in the 1930's. She held 12 national titles and won the 100-meter backstroke race in the 1932 Olympics. She was born in Brooklyn, N.Y.

Kahanamoku, Duke (1890-1968), was one of the early great crawl swimmers in the United States. Kahanamoku, who was born in Honolulu, Hawaii, held the 100-yard record from 1913 to 1921.

Kiefer, Adolph (1918-), ranked as one of the world's all-time great backstroke swimmers. He broke a world swimming record for the first time at the age of 15, and held every world backstroke record for more than 10 years. He was born in Chicago.

Kiphuth, Robert J. H. (1890-1967), was one of the most successful swimming coaches in the United States. During a 40-year career as swimming coach at Yale University, his teams won more than 500 meets and lost only 12 from 1918 to 1958. Kiphuth was born in Tonawanda, N.Y.

McIver, Helene Madison (1913-1970), reigned as the top woman swimming star of the early 1930's. In 1932, she held 15 of a possible 16 world free-style records for



Swimming Pool Age

Swimming Races furnish exciting tests of the skill and endurance of accomplished swimmers. As a race starts, above, the contestants plunge forward from short platforms in flat racing dives. Ropes divide the pool into lanes, one for each of the swimmers.

WORLD SWIMMING RECORDS*

Event	Time	Holder	Country	Made At	Date
MEN'S EVENTS					
100-meter free style	51.22 s.	Mark Spitz	United States	Munich	Sept. 3, 1972
200-meter free style	1 m. 51.66 s.	Tim Shaw	United States	Concord, Calif.	Aug. 23, 1974
400-meter free style	3 m. 54.69 s.	Tim Shaw	United States	Concord, Calif.	Aug. 22, 1974
800-meter free style	8 m. 15.88 s.	Stephen Holland	Australia	Christchurch, New Zealand	Jan. 31, 1974
1,500-meter free style	15 m. 31.75 s.	Tim Shaw	United States	Concord, Calif.	Aug. 25, 1974
100-meter breast stroke	1 m. 03.88 s.	John Hencken	United States	Concord, Calif.	Aug. 31, 1974
200-meter breast stroke	2 m. 18.21 s.	John Hencken	United States	Concord, Calif.	Sept. 1, 1974
100-meter butterfly stroke	54.27 s.	Mark Spitz	United States	Munich	Aug. 31, 1972
200-meter butterfly stroke	2 m. 00.70 s.	Mark Spitz	United States	Munich	Aug. 28, 1972
100-meter backstroke	56.30 s.	Roland Matthes	East Germany	Munich	Sept. 4, 1972
200-meter backstroke	2 m. 01.87 s.	Roland Matthes	East Germany	Belgrade	Sept. 6, 1973
200-meter individual medley	2 m. 06.32 s.	David Wilkie	Great Britain	Vienna	Aug. 24, 1974
	2 m. 06.32 s.	Steven Furniss	United States	Concord, Calif.	Sept. 1, 1974
400-meter individual medley	4 m. 28.89 s.	Andras Hargitay	Hungary	Vienna	Aug. 20, 1974
400-meter free-style relay	3 m. 25.17 s.	National Team (J. Montgomery, M. Bottom, T. Hickox, A. Coan)	United States	Concord, Calif.	Sept. 1, 1974
800-meter free-style relay	7 m. 33.22 s.	National Team (K. Krumpholz, R. Backhaus, R. Klatt, J. Montgomery)	United States	Belgrade	Sept. 7, 1973
400-meter medley relay	3 m. 48.16 s.	National Team (M. Stamm, T. Bruce, M. Spitz, J. Heidenreich)	United States	Munich	Sept. 4, 1972
WOMEN'S EVENTS					
100-meter free style	56.96 s.	Kornelia Ender	East Germany	Vienna	Aug. 19, 1974
200-meter free style	2 m. 02.94 s.	Shirley Babashoff	United States	Concord, Calif.	Aug. 23, 1974
400-meter free style	4 m. 15.77 s.	Shirley Babashoff	United States	Concord, Calif.	Aug. 22, 1974
800-meter free style	†8 m. 47.50 s.	Jo Harshbarger	United States	Concord, Calif.	Aug. 25, 1974
1,500-meter free style	16 m. 33.94 s.	Jennifer Turrall	Australia	Concord, Calif.	Aug. 25, 1974
100-meter breast stroke	1 m. 12.28 s.	Renate Vogel	East Germany	Concord, Calif.	Sept. 1, 1974
200-meter breast stroke	2 m. 34.99 s.	Karla Linke	East Germany	Vienna	Aug. 19, 1974
100-meter butterfly stroke	1 m. 01.88 s.	Rosemarie Kother	East Germany	Concord, Calif.	Sept. 1, 1974
200-meter butterfly stroke	2 m. 13.76 s.	Rosemarie Kother	East Germany	Belgrade	Sept. 8, 1973
100-meter backstroke	1 m. 02.98 s.	Ulrike Richter	East Germany	Concord, Calif.	Sept. 1, 1974
200-meter backstroke	2 m. 17.35 s.	Ulrike Richter	East Germany	Vienna	Aug. 25, 1974
200-meter individual medley	2 m. 18.97 s.	Ulrike Tauber	East Germany	Vienna	Aug. 18, 1974
400-meter individual medley	4 m. 52.42 s.	Ulrike Tauber	East Germany	Vienna	Aug. 21, 1974
400-meter free-style relay	3 m. 51.99 s.	National Team (K. Heddy, A. Marshall, K. Payton, S. Babashoff)	United States	Concord, Calif.	Aug. 8, 1974
400-meter medley relay	4 m. 13.78 s.	National Team (U. Richter, R. Vogel, R. Kother, K. Ender)	East Germany	Vienna	Aug. 24, 1974

*Includes only records set in 50-meter pools.
†Match time recorded in tenths of a second.
Source: *Amateur Athlete Yearbook* © 1975, Amateur Athletic Union of the United States.

women swimmers. She was born in South Bend, Wash.

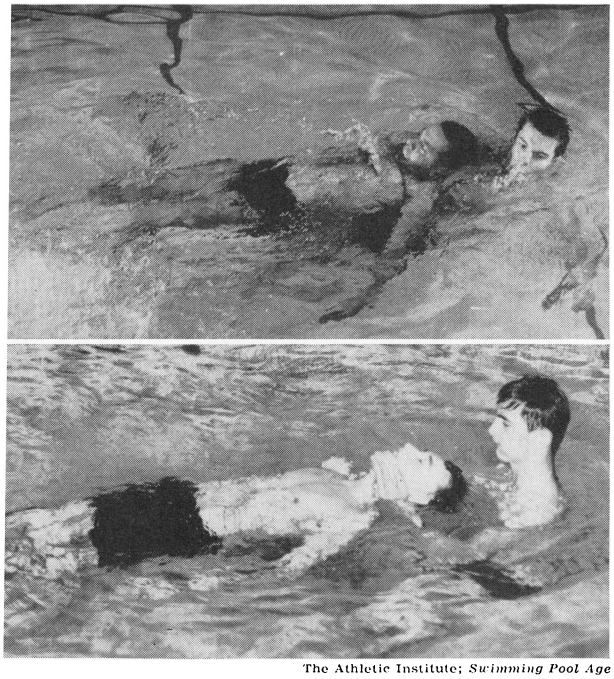
Weissmuller, Johnny (1904-), set more than 50 American and world swimming records during the 1920's. He broke the 100-yard free-style mark five times between 1922 and 1927. In the 1930's, Weissmuller achieved fame in the motion-picture role of Tarzan. John Weissmuller was born in Windber, Pa.

Water Safety

Safety in the water depends on many skills. These include a knowledge of basic water-safety rules, the ability to swim, and training in lifesaving. Every year, about 6,500 persons drown in the United States and about 1,000 in Canada. Many accidents of this sort would not happen if more people knew how to swim and how to behave in or near the water.

Water-Safety Rules. Many water accidents could be avoided if everyone followed these simple rules:

Learn to swim.
Swim only in areas protected by lifeguards.
Swim with someone who can help in an emergency.
Never jump into strange waters. Always check for depth and look for underwater obstacles.
Never leave a small child alone in or near the water.
Always swim parallel to and close to the shore.
Do not swim in or near areas where people are diving.
Enter cold water gradually.
Do not swim for at least one hour after eating.
Do not enter water during storms.
Obey rules posted at beaches and pools.



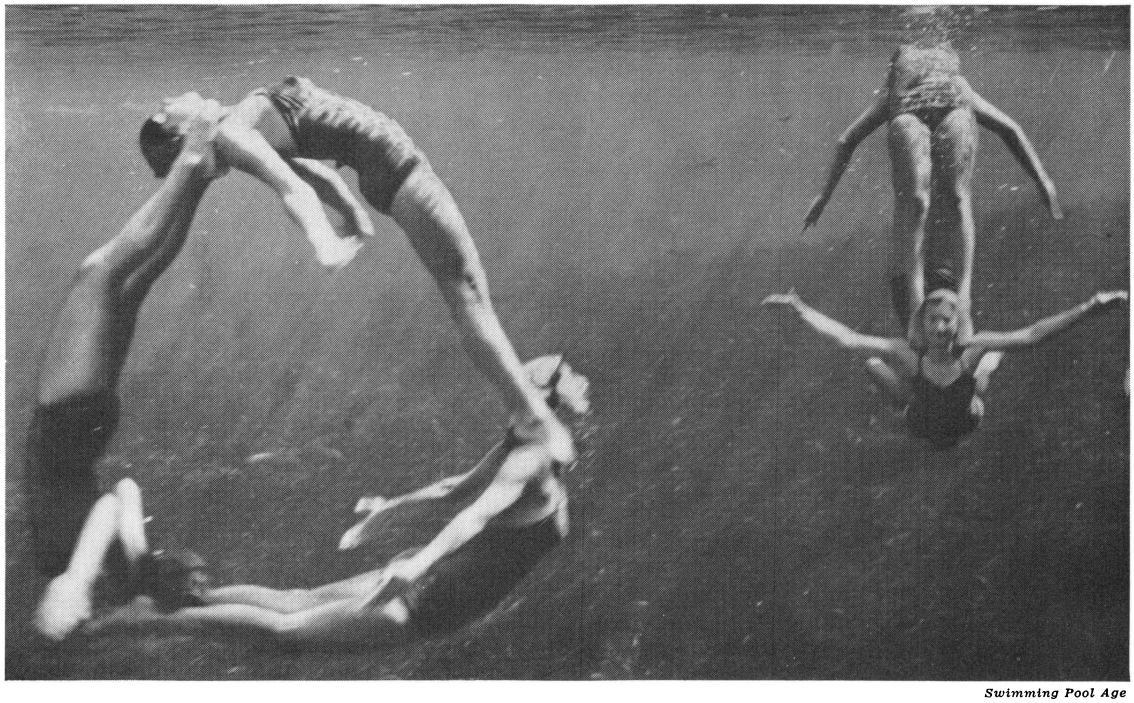
The Athletic Institute; *Swimming Pool Age*

Lifesaving Strokes include the *cross-chest carry, top,* and the *head carry, bottom.* In the cross-chest carry, the rescuer clamps an arm across the victim's chest and does a side stroke. In the head carry, the rescuer grips the victim's head in his hands, tilting it upward. He then swims backward in a sitting position and uses either a scissors kick or the regular breast-stroke kick.

Lifesaving. To earn a Red Cross Lifesaving badge, a swimmer must be able to use all the basic swimming strokes. He must also know a variety of skills, including swimming rescues, nonswimming rescues, and how to apply artificial respiration. Young persons from 12 to 15 years old can earn Red Cross Junior Lifesaving badges. Those 16 years old or older can earn Senior Lifesaving badges.

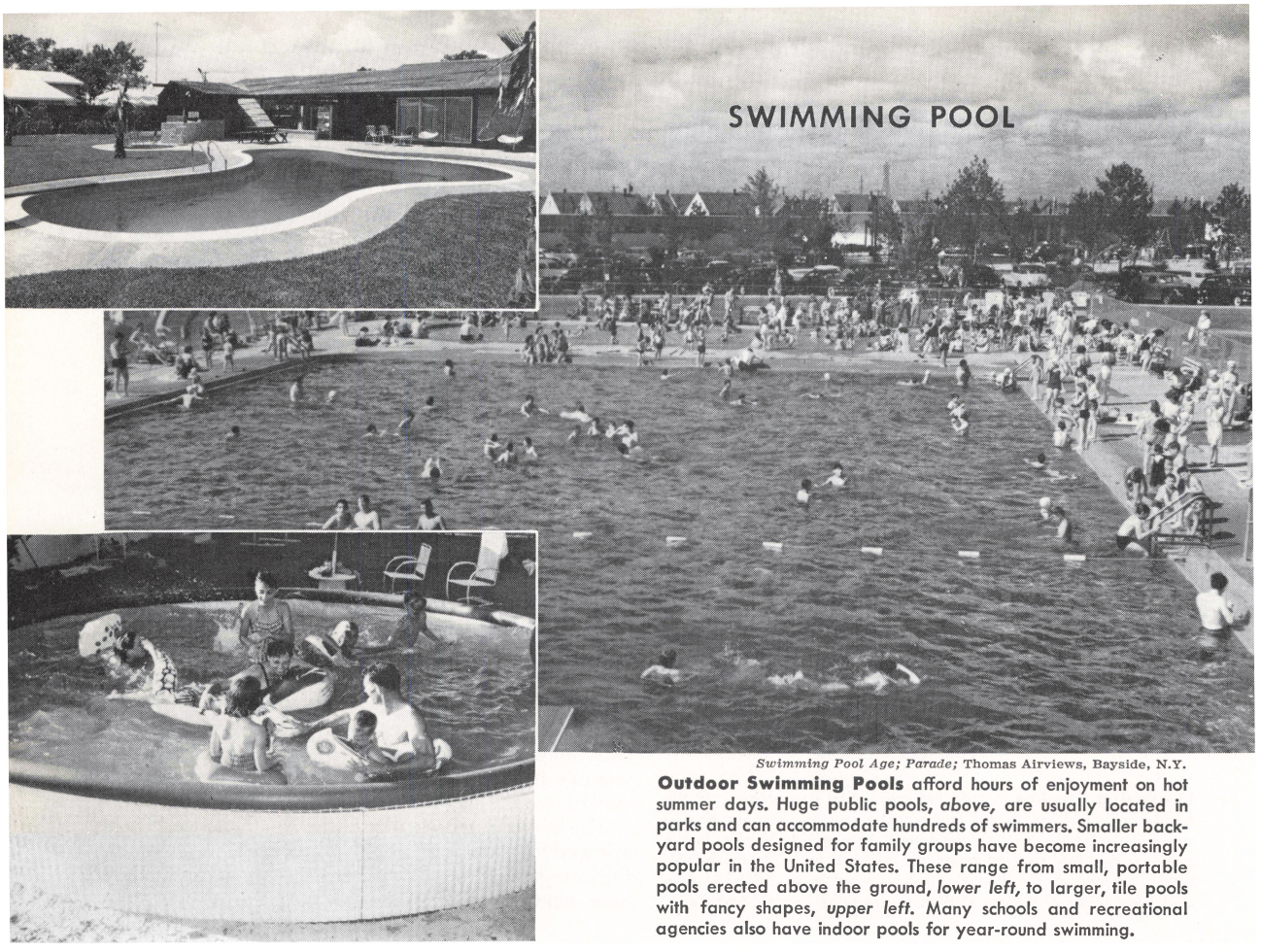
Only trained lifesavers should attempt a swimming rescue. Even a trained lifesaver should never make a swimming rescue if a safer method can be used. For example, the rescuer, without going into the water, may be able to extend an arm, leg, branch, towel, oar, or fishing rod to a drowning victim. But all lifesavers must know how to make swimming rescues. Two of the most widely used lifesaving strokes are the cross-chest carry and the head carry. The *cross-chest carry* can be used if the victim becomes violent with fear. The rescuer reaches across the victim's shoulder from behind, grasps him across the chest with one arm, and swims to shore with a modified sidestroke. The *head carry* might be used in rough water or after the victim has calmed down. The rescuer grips the victim's head in his hands and swims backward in a half-sitting position. This carry allows the rescuer to keep both his head and the victim's head above water. For descriptions of these strokes, see the pictures with this article.

The Water Safety Service of the American Red Cross offers educational programs in all phases of water safety. Other organizations with water-safety programs include high schools, colleges, the YMCA, the YWCA, the



Swimming Pool Age

Water Ballet, or *synchronized swimming,* has become a popular sport in the United States and Canada, especially for girls. The swimmers glide through graceful formations, often to music. Judges grade the swimmers in solo, duet, and team performances.



Swimming Pool Age; Parade; Thomas Airviews, Bayside, N.Y.

Outdoor Swimming Pools afford hours of enjoyment on hot summer days. Huge public pools, *above,* are usually located in parks and can accommodate hundreds of swimmers. Smaller backyard pools designed for family groups have become increasingly popular in the United States. These range from small, portable pools erected above the ground, *lower left,* to larger, tile pools with fancy shapes, *upper left.* Many schools and recreational agencies also have indoor pools for year-round swimming.

Boy Scouts and Girl Scouts, and the Boys' Clubs of America.

ADOLPH KIEFER

Related Articles in WORLD BOOK include:

Artificial Respiration
Baths and Bathing
(Modern Public Baths)
Diving
Drowning
Life Jacket
Olympic Games
Safety (Water Safety)
Skin Diving
Swimming Pool
Undertow
Water Polo

Outline

I. How to Swim
- A. Entering the Water
- B. Floating
- C. Kicking
- D. The Arm Stroke
- E. Rhythmic Breathing
- F. Swimming Strokes

II. Swimming as a Sport
- A. Swimming Meets
- B. Water Ballet

III. Famous Swimmers

IV. Water Safety
- A. Water-Safety Rules
- B. Lifesaving

Questions

What are the five basic swimming strokes?
What are seven water-safety rules?
What are two widely used lifesaving strokes?
What is the *jellyfish float?*
What kind of float starts from a squatting position?
When might a lifeguard use the *cross-chest carry?*
Who was the first woman to swim the English Channel in both directions?
About how many persons drown in the United States every year? How many in Canada?
What is an advantage of the *victory backstroke?*
What is a *medley swimming race?*

SWIMMING POOL. From ancient Greece to modern times, the swimming pool has played an important part in man's culture and society. Swimming pools were common throughout the Roman Empire. Many Roman cities had public "baths," or pools. Their indoor pools were heated by wood-burning furnaces under the floor.

Today, hundreds of cities and towns throughout the United States and Canada operate public pools for the benefit of their citizens. Many private clubs have recreational pools. The private family pool has become the center of family social life in thousands of communities. Family pools, usually lined with concrete, may be built in almost any shape to fit the terrain. But for championship swimming meets, the rules of the Amateur Athletic Union (AAU) of the United States specify that "the end walls of the pool shall be parallel and vertical, and so constructed that the competitors can push off in turning with the hands or feet."

For both indoor and outdoor competitive swimming pools, the AAU recommends a length of 50 meters and a width of 75 feet. The pool should have 8 lanes, each lane 8 feet wide, with the remaining width outside of lanes 1 and 8. An indoor pool should vary in depth from 4 feet to 16 feet. An outdoor pool should be from 4 to 6 feet deep.

For outdoor diving pools, the AAU recommends a pool 75 feet long, 60 feet wide, and from 12 to 16 feet deep. Indoor diving pools should measure 45 feet by 60 feet and be from 12 to 16 feet deep.

ESTHER WILLIAMS

SWINBURNE, ALGERNON CHARLES (1837-1909), was one of the major English poets of the 1800's. He shocked Victorian Englishmen with his devotion to pleasure and his unorthodox religious and political beliefs. The sensuality of his verse scandalized many readers. Today, Swinburne's life does not seem so unconventional, and his poetry is not regarded with alarm, as it once was.

Swinburne was born in London. He attended Oxford University but left in 1860 without earning a degree to lead a bohemian life in London. For several years, Swinburne wrote much passionate but carefully composed poetry. His style emphasized long lines with varied meters and complex rhyme schemes. Many of Swinburne's poems were inspired by Elizabethan writers, various French poets, and ancient Greek and Roman writers. Swinburne first gained fame with his verse play *Atalanta in Calydon* (1865) and his collection *Poems and Ballads* (1866).

Swinburne's pleasure-seeking way of life led to his collapse in 1879. For the rest of his life, he lived in the home of a friend, Theodore Watts-Dunton. Swinburne continued to write poetry as well as drama and literary criticism. A powerful wish for death appears in much of his later work. The *Swinburne Letters* was published in six volumes from 1959 to 1962. AVROM FLEISHMAN

SWINE. See HOG (Hog Terms).

SWING, in music. See DANCING (The 1900's); JAZZ (The Swing Era).

SWISS is a fine, sheer cotton cloth that was first made in Switzerland. The fabric may be plain, figured, or may have woven or paste dots. Swiss may be processed to remain crisp and stiff after washing. It is used in making dresses, aprons, and curtains. It comes in widths of 28, 32, and 36 inches (71, 81, and 91 centimeters) for dresses and aprons. Curtain swiss comes in widths from 36 to 40 inches (91 to 100 centimeters). Wider widths are also available for bedspreads. K. R. FOX

SWISS CHARD is a garden vegetable plant. Its leaves are eaten as greens. Swiss chard is related to the common beet plant. It resembles the beet, except that it does not have a large fleshy root. Swiss chard has a small woody root which cannot be eaten. The vegetable has fleshy leaf-stems, large leaves, and a dark green color. Some varieties of Swiss chard have pale yellow leaves and others have bright red leaves and leaf-stems. The plant has attractive, brilliant colors.

Large, Shiny Leaves of Swiss Chard have an attractive appearance in the garden. The plant is hardy and nutritious. USDA

Swiss chard is one of the few garden greens that grow constantly throughout the summer. The seeds are sown in the spring. The large outer leaves are harvested as soon as they develop. Later the inner leaves are taken, and the harvest continues until frost kills the plant.

People grew Swiss chard as long ago as 350 B.C. It is a favorite crop in Switzerland and was introduced in the United States in 1806. Massachusetts is one of the leading states in growing Swiss chard.

Swiss chard is an excellent source of vitamin A and contains a fair amount of vitamins of the B complex and C. Like most leafy vegetables, Swiss chard is also rich in minerals.

Scientific Classification. Swiss chard belongs to the goosefoot family, *Chenopodiaceae.* It is genus *Beta,* species *B. vulgaris,* variety *cicla.* ERVIN L. DENISEN

SWISS CONFEDERATION. See SWITZERLAND (History).

SWISS FAMILY ROBINSON. See WYSS (family).

SWISS GUARDS. This famous body of Swiss soldiers grew out of a group of 250 Swiss who were picked to guard the pope in the late 1400's. In the early 1500's, Pope Julius II secured the position of the Swiss Guards by a treaty with the Swiss cantons of Zurich and Lucerne. According to the terms of the agreement, the cantons supplied 250 men to serve as a bodyguard for the pope from that time on. Since then the pope has always had a body of Swiss Guards around him at the Vatican. But through the years, the number of guards has been reduced and their type of service changed. Today, they are called the Papal Swiss Guard.

Another body of Swiss soldiers, called Swiss Guards, or Switzers, was organized in 1616 to protect King Louis XIII of France. These soldiers served France for 175 years. On August 10, 1792, during the French Revolution, most of them were killed while defending the royal palace in Paris from attack by an angry mob.

The memory of these Swiss Guards is preserved in the famous "Lion of Lucerne," which is carved in the face of a rock in Lucerne, Switzerland. It bears the words, "To the Fidelity and Courage of the Helvetians." See THORVALDSEN, BERTEL (picture).

King Louis XVIII formed a second corps of Swiss Guards in 1815. They were defeated in the Revolution of 1830, and the corps disbanded. THOMAS E. GRIESS

SWITCH, ELECTRIC. See ELECTRIC SWITCH.

SWITCHBOARD. See TELEPHONE.

SWITHIN, or **SWITHUN, SAINT,** was a bishop of Winchester, England. He was a faithful adviser to Egbert and Ethelwulf, kings of the West Saxons. Swithin died in 862 and was canonized in the 900's. St. Swithin's Day is July 15. According to an old rhyme, if the weather is fair that day, it will be fair for the next 40 days. If it rains on July 15, it will rain each day for the following 40 days. See also SAINT SWITHIN'S DAY. FULTON J. SHEEN

EPA from Pictorial Parade

Villages Cling to Steep Mountain Slopes in the Swiss Alps. Many of the villages are popular tourist centers that feature winter sports.

SWITZERLAND

SWITZERLAND is a small European country known for its beautiful, snow-capped mountains and freedom-loving people. The Alps and the Jura Mountains cover more than half of Switzerland. But most of the Swiss people live on a plateau that extends across the middle of the country between the two mountain ranges. In this region are most of Switzerland's industries and its richest farmlands. Switzerland's capital, Bern, and largest city, Zurich, are also there.

The Swiss have a long tradition of freedom. About 700 years ago, people in what is now central Switzerland agreed to help each other stay free from foreign rule. Gradually, people in nearby areas joined them in what came to be known as the Swiss Confederation. There have long been language differences among the various Swiss groups, and Switzerland has three official languages—German, French, and Italian. The Latin name for Switzerland, *Helvetia*, appears on Swiss coins and postage stamps.

The Swiss show great pride in their long independence. Switzerland has no regular army, but almost all the men receive military training yearly. They keep their weapons and uniforms at home, and can be called up quickly in an emergency. Local marksmanship contests are held frequently.

In the early 1500's, Switzerland established a policy of not taking sides in the many wars that raged in Europe. During World Wars I and II, Switzerland remained an island of peace. Almost all the nations around it took part in the bloody struggles. Switzerland provided safety for thousands who fled from the fighting, or from political persecution. The nation's neutrality policy helped the Swiss develop valuable banking services to people of countries throughout the world, where banks are less safe. The League of Nations, the major world organization of the 1920's and 1930's, had its headquarters in the Swiss city of Geneva. Today, many international organizations, including various United Nations agencies, have headquarters in Geneva.

Switzerland has limited natural resources, but it is a thriving industrial nation. Using imported raw materials, the Swiss manufacture high-quality goods including electrical equipment, industrial machinery, and watches. They also produce large amounts of cheese and other dairy products and chocolate.

The contributors of this article are Heinz K. Meier, Louis I. Jaffé Professor of History at Old Dominion University and author of Friendship Under Stress: U.S.-Swiss Relations 1900-1950; *and Norman J. G. Pounds, University Professor of Geography and History at Indiana University.*

FACTS IN BRIEF

Capital: Bern.

Official Languages: German, French, and Italian.

Official Names: Schweiz (in German), Suisse (in French), and Svizzera (in Italian).

Area: 15,941 sq. mi. (41,288 km²), including 523 sq. mi. (1,355 km²) of inland water. *Greatest Distances*—east-west, 213 mi. (343 km); north-south, 138 mi. (222 km).

Elevation: *Highest*—Dufourspitze of Monte Rosa, 15,203 ft. (4,634 m) above sea level. *Lowest*—shore of Lake Maggiore, 633 ft. (193 m) above sea level.

Population: *Estimated 1976 Population*—6,736,000; distribution, 62 per cent urban, 38 per cent rural; density, 422 persons per sq. mi. (163 per km²). *1970 Census*—6,269,783. *Estimated 1981 Population*—7,150,000.

Chief Products: *Agriculture*—dairy products, fruits, hay, potatoes, wheat. *Manufacturing*—chemicals, electrical equipment, industrial machinery, precision instruments, processed foods, textiles, watches.

National Anthem: "Swiss Hymn."

National Holiday: Swiss National Day, August 1.

Money: *Basic Unit*—franc. See MONEY (table: Values).

The government of Switzerland is based on the Swiss Constitution of 1848, which was changed greatly in 1874. The Constitution establishes a *federal republic* in which political powers are divided between the central government and regional governments.

In some ways, the Swiss government is one of the most democratic in the world. A majority of the voters must approve any *amendment* (change) to the Constitution. If 50,000 persons request an amendment, it must be brought to a vote even if the legislature has rejected it. A law must be voted on if, within 90 days after being passed, 30,000 persons or 8 *cantons* (states) request such action. Voters must be at least 20 years old.

Swiss democracy does have one important weakness: most women do not have a voice in local matters. Women have been allowed to vote in national elections only since 1971.

Regional and Local Government. Swiss voters elect executive councils and legislatures in the cantons, half-cantons, and cities. The country's six half-cantons were originally three undivided cantons. They split into separate political units with as much power of self-government as the full cantons. But each half-canton sends only one representative to the national legislature's Council of States, instead of two.

In one canton and in four of the half-cantons, the people vote by a show of hands at an open-air meeting called a *Landsgemeinde*. Similar meetings of voters are held in the small towns and villages.

Politics. Switzerland has many political parties, but there are few differences among the large ones. As a result, the parties cooperate easily. The three largest parties have about the same strength. They are the Catholic Conservative Party, the Radical Democratic Party, and the Social Democratic Party.

Defense. Switzerland has a *militia* (citizens' army) instead of regular armed forces. Swiss men are required to begin a series of military-training periods at the age of 20. They can be called into service until the age of 50. Men whose health or work makes them unable to serve, and those who live out of the country, must pay a special tax based on income and property.

GOVERNMENT IN BRIEF

Political Divisions: 22 *cantons* (states), 3 of which are divided into half-cantons.

Executive: Federal Council, a 7-member Cabinet elected by the legislature to 4-year terms. They serve in place of a single chief executive.

Head of State: President, elected to a 1-year term by the legislature from among the members of the Federal Council. His duties are largely ceremonial. A man cannot be elected president two years in a row.

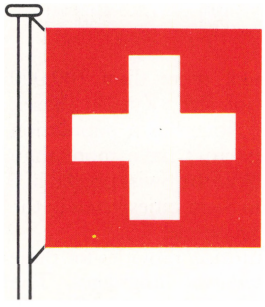
Legislature: A two-house Federal Assembly. *Council of States*—44 members. Two members are elected from each canton (one is elected from each half-canton), either by the canton legislature or by the voters. Their terms range from 1 to 4 years. *National Council*—200 members, elected to 4-year terms from election districts based on population.

Courts: *Highest Court*—the Federal Tribunal. It has 26 judges and 12 alternate judges, elected to 6-year terms by the Federal Assembly. Various lower courts are in the cantons.

EPA from Pictorial Parade

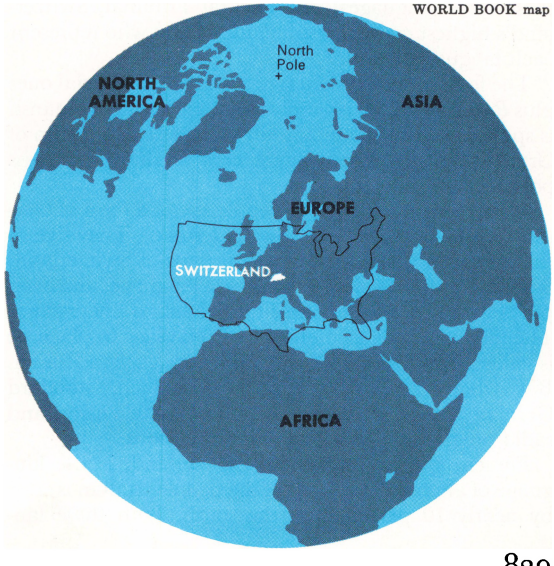
Federal Parliament Buildings in Bern are the meeting places of the Council of States and the National Council.

The Swiss Flag was used in an earlier form in 1240 by the region of Schwyz. The cross represents Christianity.



The Coat of Arms of Switzerland, like the Swiss flag, was established with its present dimensions in 1889.

Switzerland, a country east of France, is less than 1 per cent as large as the United States, not counting Alaska and Hawaii.



Even after the Swiss began to join forces about 700 years ago to defend themselves, people from different areas kept their own ways of life. They defended these ways of life in the same spirit of independence that has made Switzerland famous. As a result, the Swiss still differ greatly among themselves in language, customs, and traditions. These differences are apparent from region to region, and even from some small communities to others. For example, a person in one mountain valley may not be able to understand someone who lives in the next valley.

In the past, the local patriotism of the Swiss was so strong that most of them thought of themselves as part of their own local area more than of their country. They considered the Swiss of other areas almost as foreign rivals, and feuds among various areas lasted for hundreds of years. But at most times when their country faced possible danger, the Swiss stood together as one people. Today, strong local patriotism has largely been replaced by national patriotism.

Population. In 1976, Switzerland had an estimated population of 6,736,000. The following table shows some official census figures for Switzerland:

1850	2,392,740	1930	4,066,400
1870	2,655,001	1940	4,265,703
1888	2,917,754	1950	4,714,992
1900	3,315,443	1960	5,429,061
1910	3,753,293	1970	6,269,783
1920	3,880,320		

Switzerland has five cities of more than 100,000 persons. They are, in order of size, Zurich, Basel, Geneva, Bern, and Lausanne. None has a population over 500,000. About 80 other cities have more than 10,000 persons. About two-fifths of the Swiss people live in rural areas. See the articles on Swiss cities listed in the *Related Articles* at the end of this article.

Language. The Swiss Constitution provides for three *official* languages and four *national* languages. The official languages are German, French, and Italian. As a result, Switzerland has three official names—Schweiz (in German), Suisse (in French), and Svizzera (in Italian). All national laws are published in each of these three languages. The Federal Tribunal, Switzerland's highest court, must include judges who represent each language group.

The four national languages are the three official ones plus *Romansh*, which is closely related to Latin. Romansh is spoken only in the mountain valleys of the canton of Graubünden, by about 1 per cent of the total Swiss population.

About 70 per cent of the people speak a form of German called *Schwyzerdütsch* (Swiss German). They live in the northern, eastern, and central parts of Switzerland. Schwyzerdütsch is almost a separate language, and even people who speak German find it hard to understand. The language and its name vary from place to place. It is called *Baseldütsch* in Basel, and *Züridütsch* in Zurich. But wherever Schwyzerdütsch is spoken, standard German is used in newspapers, books, television and radio programs, plays, and church sermons.

French, spoken in western Switzerland, is the language of almost 20 per cent of the people. Italian is used by nearly 10 per cent, in the south. Both these languages, as spoken by the Swiss, are much like their standard forms in France or Italy.

One difficulty, especially for visitors, is that many place names in Switzerland vary by language. The most complicated example—the city known as *Geneva* to English-speaking people—is called *Genf* in German, *Genève* in French, and *Ginevra* in Italian. English-speaking people know almost all other Swiss cities and towns by their French or German name.

Religion. Switzerland has complete freedom of religion. A little more than half the people are Protestants, and over 45 per cent are Roman Catholics. Of the nation's 25 cantons and half-cantons, 11 are chiefly Protestant and 14 have a Roman Catholic majority.

The Protestant Reformation took a special form in Switzerland. Calvinism developed there and spread to many other countries during the 1500's. As a result, the Protestant movement split into two major camps, Calvinists and Lutherans. See CALVIN, JOHN; REFORMATION (Zwingli and the Anabaptists); ZWINGLI, HULDREICH.

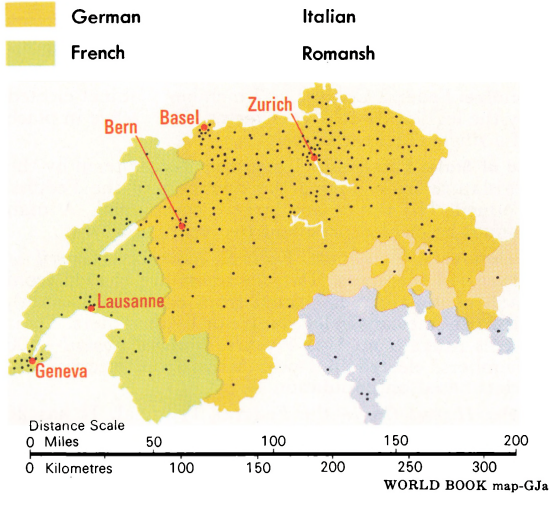
Education. Swiss children are required by canton law to go to school, but the age limits vary. In most cantons, children must attend school from 6 through 14. Instruction is held in the local national language, and each child may also learn one of the other national languages.

Students who plan to attend a university may go to one of three kinds of high schools. These schools specialize in (1) Greek and Latin, (2) Latin and modern languages, or (3) mathematics and science. Other students may go to trade or technical schools while serving an apprenticeship. They cannot advance in their work without graduating from one of these schools.

Switzerland has seven universities and various other

POPULATION AND LANGUAGE

This map shows the population distribution of Switzerland, and the largest Swiss cities. Each dot represents about 20,000 persons. The map also shows where the national languages are spoken. Most Swiss speak a form of German called *Schwyzerdütsch*.



schools of higher learning. The oldest, the University of Basel, was founded in 1460. The University of Zurich, with about 10,000 students, is the largest. University fees are low. At the University of Zurich, for example, students pay only $1.50 per semester hour.

Arts. Most Swiss literature has been written in German. Famous books include two children's classics, *Heidi* by Johanna Spyri and *The Swiss Family Robinson* by the Wyss family. Major Swiss authors of the 1800's were Jeremias Gotthelf, Gottfried Keller, and Conrad Ferdinand Meyer. Carl Spitteler won the Nobel prize in literature in 1919 for his epic poetry and other writings. Later writers of the 1900's include Max Frisch and Friedrich Dürrenmatt, whose plays have been performed in many countries. Charles Ferdinand Ramuz wrote novels in French.

The art movement called *Dadaism* was founded in Zurich in 1916 (see DADAISM). Outstanding Swiss artists of the 1900's include the painter Paul Klee and the sculptors Alberto Giacometti and Jean Tinguely. Le Corbusier won fame in modern architecture.

Several Swiss cities have symphony orchestras. The Orchestre de la Suisse Romande of Geneva became world famous under conductor Ernest Ansermet. An annual music festival in Lucerne attracts thousands of music lovers. Almost every town and village has a singing group that practices weekly for local festivals, and for regional and national singing competitions. Band music and folk dancing in colorful national costumes are also popular. Some mountaineers enjoy yodeling or playing the alpenhorn (see ALPENHORN; YODEL).

Sports. The mountains of Switzerland provide grand opportunities for a variety of sports. About a third of the people ski. Many also enjoy bobsledding, camping, climbing, and hiking in the mountains. Target shooting, stressed by the Swiss military system, is extremely popular. Shooting matches are held frequently. Other favorite sports include bicycling, boating, gymnastics, soccer, swimming, and wrestling. *Hornussen*, a national game somewhat like baseball, is played by two teams. The batter hits a wooden disk with a wooden club 8 feet (2.4 meters) long. Fielders catch the disk with wooden rackets.

William Froelich

Outdoor Flower Markets brighten many busy cities of Switzerland. This market is in Geneva, the third largest Swiss city.

Mort Beebe, Photo Researchers

Local Festivals, *above,* are often held throughout Switzerland. Many people dress in national costumes for these celebrations.

Robert Perron, Photo Researchers

Men Wait to Vote by Hand at an open-air meeting, *left.* The swords held by the men indicate their right to vote.

SWITZERLAND / *The Land*

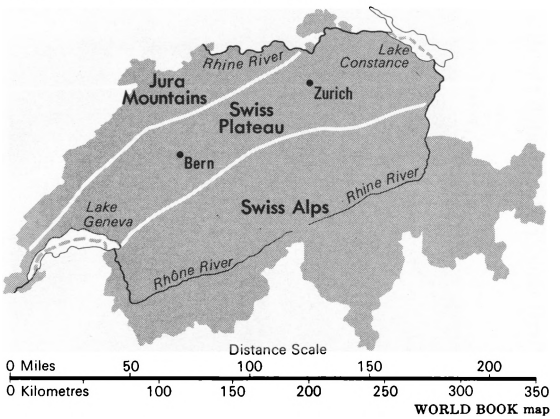
Switzerland has three main land regions: (1) the Jura Mountains, (2) the Swiss Plateau, and (3) the Swiss Alps. The two mountain regions make up about 70 per cent of Switzerland's area. But the plateau between them has about two-thirds of the country's population.

The Jura Mountains consist of a series of parallel ridges that are separated by narrow valleys. These ridges extend along Switzerland's western border with France. Within Switzerland, the highest mountain of the range is 5,518-foot (1,682-meter) Mont Tendre. The Jura Mountains are the home of Switzerland's important watchmaking industry. Other industries in the region include dairy farming and lumbering. See JURA.

The Swiss Plateau is a hilly region with rolling plains. It lies from 1,200 to 2,200 feet (366 to 671 meters) above sea level. The movement of ancient glaciers formed many lakes, including Lake Constance and Lake Geneva. Switzerland's richest croplands and grazing lands are in this region, as well as most of the large cities and manufacturing industries. See LAKE CONSTANCE; LAKE GENEVA.

The Swiss Alps are part of the mighty Alps, the

LAND REGIONS OF SWITZERLAND



WORLD BOOK map

SWITZERLAND MAP INDEX

Cantons†

AARGAU (ARGOVIE) ...409,000..A 4
APPENZELL ...63,900..A 5
Ausser Rhoden‡ 50,500
Inner Rhoden‡ 13,400
BASEL (BÂLE) 422,200..A 3
Basel-Land‡ ..188,800
Basel-Stadt‡ ..233,400
BERN (BERNE) 980,000..B 3
FRIBOURG (FREIBURG) .170,000..B 3
GENÈVE (GENF) (GENEVA) .309,600..B 2
GLARUS (GLARIS) 41,500..B 5
GRAUBÜNDEN (GRISONS) .145,000..B 5
LUZERN (LUCERNE) 278,000..A 4
NEUCHÂTEL (NEUENBURG .164,000..B 2
ST. GALLEN (ST. GALL) .369,000..A 5
SCHAFFHAUSEN (SCHAFFHOUSE) .72,000..A 4
SCHWYZ ..84,000..A 4
SOLOTHURN (SOLEURE) 223,000..A 3
THURGAU (THURGOVIE) 185,000..A 5
TICINO (TESSIN) ..230,000..B 4
UNTERWALDEN (UNTERWALD) .48,900..B 4
Nidwalden‡ 24,200
Obwalden‡ 24,700
URI .....33,000..B 4
VALAIS (WALLIS) ...185,000..B 3
VAUD (WAADT) 493,000..B 2
ZUG (ZOUG) .63,900..A 4
ZÜRICH (ZURICH) 1,066,000..A 4

Cities and Towns

Aarau 17,500
*49,200..A 4
Aarburg* ...5,303..A 3
Adliswil ...13,700..A 4
Allschwil ..16,300..A 3
Altdorf ....7,477..B 4
Altstätten ..8,751..A 5
Amriswil ...6,752..A 5
Appenzell ...5,082..A 5
Arbon ....13,100..A 5
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Arosa .....2,600..B 5
Arth .....6,321..A 4
Baar .....12,300..A 4
Baden 15,000
*56,200..A 4
Balsthal ....5,735..A 3
Basel 212,100
*358,700..A 3
Bellinzona .16,000
*27,200..B 5
Bern 166,800
*254,900..B 3
Biberist ....7,188..A 3
Biel 66,800
*89,000..A 3
Binningen .14,800..A 3
Birsfelden* 13,100..A 3
Bolligen ...23,200..B 3
Brugg .....6,683..A 4
Buchs .....6,345..A 5
Buchs* .....5,734..A 4
Bülach ....10,600..A 4
Bulle .....5,983..B 3
Burgdorf ..16,000
*19,300..A 3
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Cham .....6,483..A 4
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Chêne-Bourg* ....5,027..B 2
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Chur .....29,600..B 5
Davos .....11,600..B 5
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Dietikon ...21,300..A 4
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Einsiedeln ..8,792..A 4
Emmen ....21,800..A 4
Flawil .....7,256..A 5
Frauenfeld .17,100..A 4
Freienbach* .5,520..A 4
Fribourg ...40,000
*50,500..B 3
Frutigen ....5,565..B 3
Geneva (Genève) 170,500
*301,000..B 2
Glarus .....5,852..A 5
Goldach ....6,233..A 5
Gossau ....11,400..A 5
Grenchen ..20,300
*24,100..A 3
Henau .....7,828..A 5
Herisau ...15,400..A 5
Horgen ....15,400..A 4
Horw* .....7,638..A 4
Illnau .....6,160..A 4
Ingenbohl* ..5,046..A 4
Interlaken ..4,738..B 3
Jona* .....5,686..A 4
Kilchberg* ..6,784..A 4
Kirchberg ...5,554..A 5
Kloten ....15,600..A 4
Köniz ....31,500..B 3
Kreuzlingen 15,000..A 5
Kriens ....18,400..A 4
Küsnacht ..12,400..A 4
Küssnacht am Rigi ..6,287..A 4
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Lancy ....18,300..B 2
Langenthal 12,700..A 3
Langnau [in Emmental] 9,201..B 3
La Tour-de-Peilz ....6,820..B 2
Lausanne .136,600
*210,900..B 2
Le Chenit ...5,242..B 2
Le Locle ...15,400..A 2
Lenzburg* ..6,378..A 4
Liestal 11,200
*20,800..A 3
Littau ....12,100..A 4
Locarno ...13,200
*22,300..B 4
Lucerne (Luzern) 73,700
*146,700..A 4
Lugano 22,200
*53,900..B 4
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Männedorf* .6,182..A 4
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Meilen .....8,203..A 4
Mels* .....5,254..A 5
Mendrisio ...5,109..C 4
Meyrin* ...12,300..B 2
Monthey ....6,834..B 2
Montreux ..19,900
*20,800..B 2
Morges ....11,200..B 2
Moutier ....7,472..A 3
München-stein ....11,600..A 3
Münsingen ..6,051..B 3
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Muttenz ...14,600..A 3
Neuchâtel .36,400
*53,600..B 2
Neuhausen [am Rheinfall]*12,100..A 4
Nyon .....10,800..B 2
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*47,600..A 3
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Pully .....15,700..B 2
Rapperswil ..7,585..A 4
Reinach ....5,174..A 4
Reinach ....11,500..A 3
Renens ....16,200..B 2
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Richterswil* 5,842..A 4
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Ste. Croix ..6,925..B 2
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*58,500..A 4
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Schwyz ....12,200..A 4
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*36,900..A 3
Spiez .....8,168..B 3
Stäfa .....6,947..A 4
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Suhr .....6,398..A 4
Sumiswald ..5,525..A 3
Sursee .....5,324..A 4
Teufen .....5,110..A 5
Thalwil ....13,000..A 4
Thun 34,700
*58,100..B 3
Tramelan ...5,567..A 3
Trimbach ...5,784..A 3
Uster .....21,100..A 4
Vernier ....17,000..B 2
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*30,400..B 2
Wädenswil .14,600..A 4
Wald .....7,778..A 4
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Wattwil ....7,480..A 5
Weinfelden .6,954..A 5
Wettingen .20,000..A 4
Wetzikon ..13,000..A 4
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Windisch* ..5,377..A 4
Winterthur 91,000
*103,100..A 4
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Worb* .....5,885..B 3
Yverdon ...19,900..B 2
Zofingen ....8,779..A 3
Zollikofen ..6,237..A 3
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Zug .....22,500..A 4
Zurich 432,500
*663,900..A 4

Physical Features

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Bernina Pass .....B 6
Birs River .....A 3
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Broye River .....B 2
Chasseral (Mt.) ...A 3
Dent du Midi (Mt.) .....B 2
Diablerets (Mt.) ...B 3
Dom (Mt.) .....B 3
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Furka Pass .....B 4
Glärnisch (Mt.) ..B 4
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Great Saint Bernard Tunnel .....C 3
Hallwil Lake (Hallwilersee) ...A 4
Inn River .....B 5
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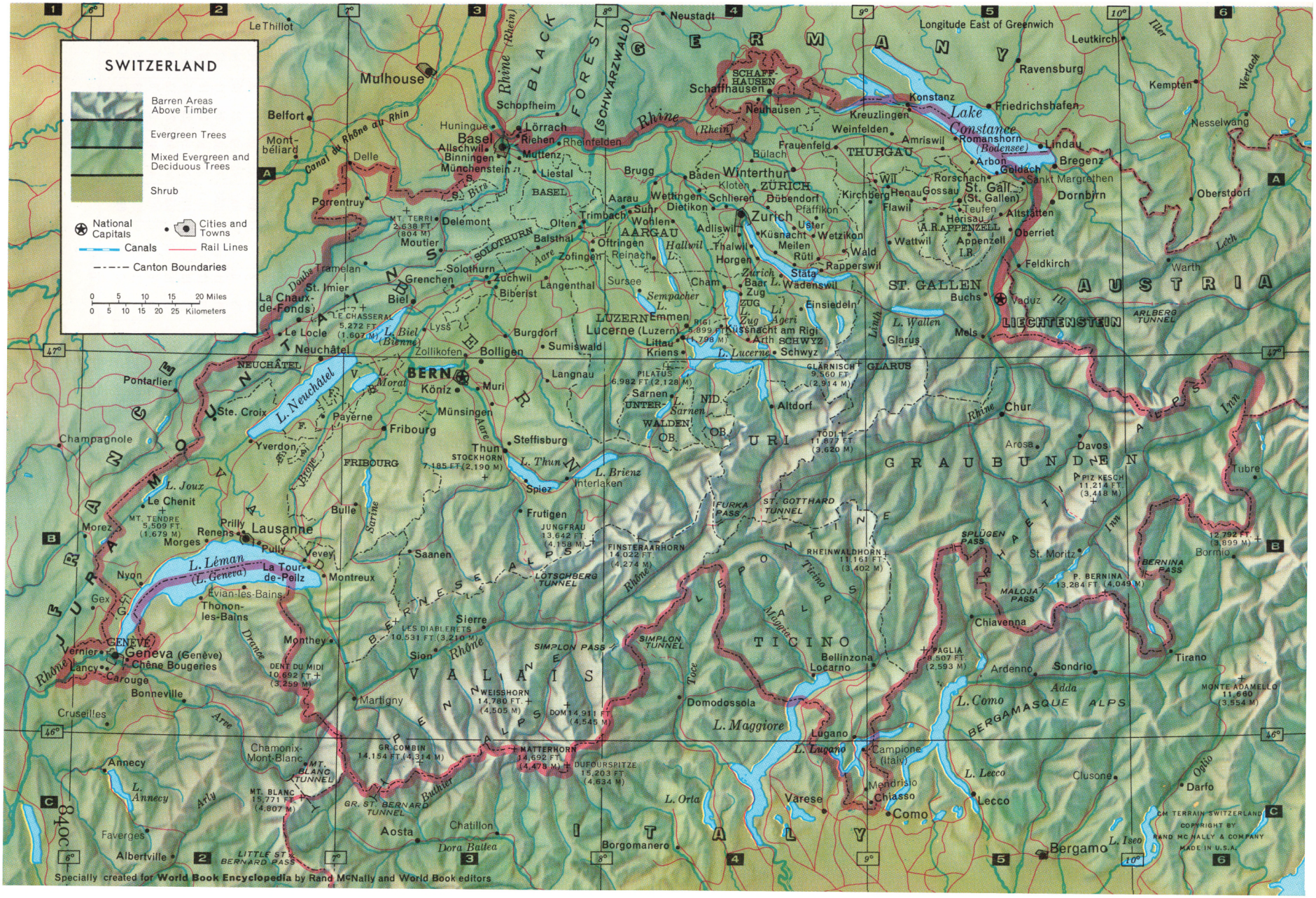
Lac Léman (Lake Geneva) .....B 2
Lake Ageri (Agerisee) .....A 4
Lake Biel (Bielersee) .....A 3
Lake Brienz (Brienzersee) ....B 3
Lake Constance (Bodensee) .....A 5
Lake Geneva, see Lac Léman
Lake Joux (Lac de Joux) .....B 2
Lake Lugano .....C 4
Lake Maggiore .....B 4
Lake Morat (Murtensee) .....B 3
Lake Neuchâtel (Lac de Neuchâtel) ...B 2
Lake of Lucerne ...A 4
Lake of Thun (Thunersee) .....B 3
Lake Sarnen (Sarnersee) .....B 4
Lake Wallen (Wallensee) .....A 5
Lake Zug (Zugersee) .....A 4
Lepontine Alps (Mts.) .....B 4
Lötschberg Tunnel .B 3
Matterhorn (Mt.) ..C 3
Monte Rosa (Mt.) ..C 3
Pennine Alps (Mts.) .....B 3
Rhaetian Alps (Mts.) .....B 5
Rhine River .....B 5
Rhône River .....B 3
Saint Gotthard Tunnel .....B 4
Simplon Pass and Tunnel .....B 4
Splügen Pass .....B 5
Staubbach (Waterfall)* .....B 3
Tendre, Mont (Mt.) .....B 2
Ticino River .....B 4
Trümmelbach (Waterfall)* .....B 3
Zurich Lake (Zurichsee) .....A 4

†Name in German, French, or Italian, according to most spoken language; alternative names in parentheses.
‡Half-Cantons.
*Population of metropolitan area, including suburbs.
*Does not appear on map; key shows general location.
Sources: 1968 official estimates for cantons and cities over 10,000; 1960 census for other places.


SWITZERLAND
Barren Areas Above Timber
Evergreen Trees
Mixed Evergreen and Deciduous Trees
Shrub
National Capitals
Cities and Towns
Canals
Rail Lines
Canton Boundaries
0 5 10 15 20 Miles
0 5 10 15 20 25 Kilometers
Longitude East of Greenwich
GERMANY
AUSTRIA
FRANCE
ITALY
LIECHTENSTEIN
Lake Constance (Bodensee)
Rhine (Rhein)
BLACK FOREST (SCHWARZWALD)
Basel
Zurich
Bern
Geneva (Genève)
Lausanne
Lucerne (Luzern)
Interlaken
Lugano
Chur
St. Gallen
Aargau
Thurgau
Ticino
Valais
Vaud
Graubünden
Neuchâtel
Fribourg
Solothurn
Schaffhausen
Appenzell
Glarus
Schwyz
Uri
Obwalden
Nidwalden
Zug
Jura Mts.
Bernese Alps
Lepontine Alps
Rhaetian Alps
Pennine Alps
Mont Blanc
Matterhorn
Jungfrau
Weisshorn
Dom
Dufourspitze
Finsteraarhorn
Rheinwaldhorn
Piz Bernina
Piz Kesch
Tödi
Glärnisch
Pilatus
Furka Pass
St. Gotthard Tunnel
Simplon Pass
Simplon Tunnel
Lötschberg Tunnel
Splügen Pass
Maloja Pass
Bernina Pass
Mt. Blanc Tunnel
Gr. St. Bernard Tunnel
Arlberg Tunnel
Lake Geneva
Lake Maggiore
Lake Como
Lake Lugano
Lake Neuchâtel
Lake Zurich
Lake Wallen
Lake Thun
Lake Brienz
Lake Lucerne
Lake Sempach
Lake Zug
Lake Biel (Bienne)
Lake Morat
Lake Annecy
Lake Orta
Lake Iseo
Mulhouse
Belfort
Montbéliard
Le Thillot
Porrentruy
Delémont
Moutier
Biel
St. Imier
La Chaux-de-Fonds
Le Locle
Neuchâtel
Pontarlier
Ste. Croix
Yverdon
Payerne
Fribourg
Murten
Solothurn
Olten
Aarau
Baden
Brugg
Winterthur
Kloten
Schaffhausen
Konstanz
Kreuzlingen
Romanshorn
Arbon
Rorschach
St. Gallen
Wil
Frauenfeld
Weinfelden
Amriswil
Bregenz
Dornbirn
Feldkirch
Buchs
Vaduz
Mels
Glarus
Altdorf
Chur
Arosa
Davos
Tubre
Bormio
Sondrio
Tirano
Chiavenna
Bellinzona
Locarno
Ascona
Domodossola
Lugano
Como
Varese
Chiasso
Mendrisio
Campione (Italy)
Lecco
Clusone
Darfo
Bergamo
Sion
Martigny
Monthey
Sierre
Vernier
Lancy
Carouge
Bonneville
Cruseilles
Annecy
Chamonix-Mont-Blanc
Aosta
Chatillon
Faverges
Albertville
Thonon-les-Bains
Evian-les-Bains
Gex
Morges
Renens
Prilly
Pully
Vevey
Montreux
La Tour-de-Peilz
Nyon
Morez
Champagnole
Le Chenit
Bulle
Frutigen
Spiez
Steffisburg
Thun
Langnau
Sumiswald
Burgdorf
Langenthal
Zofingen
Aarburg
Olten
Trimbach
Wohlen
Suhr
Aarau
Wettingen
Dietikon
Schlieren
Zurich
Dübendorf
Pfäffikon
Uster
Wetzikon
Meilen
Rapperswil
Horgen
Thalwil
Adliswil
Küsnacht
Wädenswil
Einsiedeln
Arth
Küssnacht am Rigi
Rigi
Zollikofen
Bolligen
Münsingen
Köniz
Lyss
Grenchen
Zuchwil
Biberist
Balsthal
Oftringen
Reinach
Muttenz
Binningen
Allschwil
Riehen
Rheinfelden
Lörrach
Huningue
Schopfheim
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Pilatus
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Rheinwaldhorn
Weisshorn
Dom
Matterhorn
Dufourspitze
Gr. Combin
Mont Blanc
Dent du Midi
Les Diablerets
Mt. Terri
Le Chasseral
Pizzo Centrale
Pizzo Lucendro
Pizzo Rotondo
Pizzo Gallina
Pizzo Forno
Pizzo Tambo
Pizzo Bernina
Pizzo Scalino
Monte Adamello
Monte Paglia
Monte Generoso
Monte Rosa
Monte Leone
Monte Cervino
Monte Viso
Monte Disgrazia
Monte Legnone
Monte Grappa
Monte Pasubio
Monte Baldo
Monte Stella
Monte Resegone
Monte Grigna
Monte Pizzo
Monte Cimone
Monte Corno
Monte Cornizzolo
Monte Generoso
Monte Tamaro
Monte Camoghè
Monte Gambarogno
Monte Ceneri
Monte Boglia
Monte Lema
Monte Gridone
Monte Mottarone
Monte Rosa
Monte Leone
Monte Cervino
Monte Viso
Monte Disgrazia
Monte Legnone
Monte Grappa
Monte Pasubio
Monte Baldo
Monte Stella
Monte Resegone
Monte Grigna
Monte Pizzo
Monte Cimone
Monte Corno
Monte Cornizzolo
Monte Generoso
Monte Tamaro
Monte Camoghè
Monte Gambarogno
Monte Ceneri
Monte Boglia
Monte Lema
Monte Gridone
Monte Mottarone
Rhine (Rhein)
Aare
Reuss
Limmat
Linth
Ticino
Adda
Oglio
Inn
Doubs
Broye
Sarine
Arve
Arly
Drance
Rhône
Toce
Maggia
Tresa
Lambro
Olona
Seprio
Brianza
Bergamasque Alps
Lepontine Alps
Rhaetian Alps
Pennine Alps
Bernese Alps
Jura Mts.
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CM TERRAIN SWITZERLAND
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largest mountain system in Europe. This high, rugged region covers about 60 per cent of Switzerland, but less than a fifth of the people live there. There are glaciers as low as 3,500 feet (1,070 meters) above sea level, and snow blankets most of the region from three to five months a year. Much of the region is forested. The forests help prevent snow from sliding down to the valleys, but avalanches sometimes occur.

The upper valleys of the Rhine and Rhône rivers divide the Swiss Alps into a northern and a southern series of ranges. These ranges include the Bernese, Lepontine, Pennine, and Rhaetian Alps. Ancient glaciers carved out sharp peaks, jagged ridges, and steep gorges. Many mountain streams form plunging waterfalls. The highest waterfall is the 984-foot (300-meter) Staubbach in the Bernese Alps. The Pennine Alps include Switzerland's highest peak, the 15,203-foot (4,634-meter) Dufourspitze of Monte Rosa. The spectacular beauty of the Swiss Alps attracts tourists from all parts of the world. See ALPS.

Rivers. The Swiss Alps form part of Europe's main drainage divide. They are the source of rivers that flow in all directions. The Rhine and the Rhône rivers rise within 15 miles (24 kilometers) of each other in the Alps, but flow in opposite directions. The Rhine flows into the North Sea, and the Rhône into the Mediterranean Sea. The Inn River winds into the Danube River, which goes into the Black Sea. The Ticino River is a tributary of the Po River, which flows into the Adriatic Sea. See INN RIVER; RHINE RIVER; RHÔNE RIVER.

EPA from Pictorial Parade

Ticino, the Southernmost Swiss Canton, is the warmest part of the country. It has hot summers and mild winters.

SWITZERLAND / *Climate*

The climate of Switzerland varies greatly from area to area because of the wide variety in altitude. In general, temperatures decrease about 3° F. (2° C) with each 1,000-foot (300-meter) increase in elevation, and higher areas receive more rain and snow. Cold air from nearby mountains often settles over lower areas, producing extreme dampness and fog. Fog sometimes covers the entire Swiss Plateau like a sea of clouds. Some low areas may be covered as many as 120 days a year.

January temperatures average from 29° to 33° F. (−2° to 1° C) on the central plateau and in the mountain valleys. In winter, there is colder though drier and sunnier weather above the layer of fog than below it. In summer, the plateau is warm and sunny, but severe storms may occur. July temperatures on the plateau average from 65° to 70° F. (18° to 21° C). Many sheltered valleys sometimes become uncomfortably hot. In summer, the higher slopes are cool or even cold. The canton of Ticino, which extends southward to the Italian plains, has hot summers and mild winters.

The central plateau receives from 40 to 45 inches (100 to 114 centimeters) of *precipitation* (rain, melted snow, and other forms of moisture) a year. Sheltered valleys usually have less. In some high areas, the yearly precipitation totals more than 100 inches (250 centimeters). Above 6,000 feet (1,800 meters), snow covers the ground at least six months a year.

A dry, warm southerly wind called the *foehn* sometimes blows into valleys in the Swiss Alps. It causes rapid changes in temperature and air pressure, which makes many people uncomfortable. This wind also may melt mountain snows earlier than usual, causing severe avalanches.

AVERAGE MONTHLY WEATHER

	BERN					LUGANO				
	Temperatures				Days of Rain or Snow	Temperatures				Days of Rain or Snow
	F°		C°			F°		C°		
	High	Low	High	Low		High	Low	High	Low	
JAN.	35	26	2	-3	11	43	29	6	-2	7
FEB.	40	27	4	-3	10	48	30	9	-1	6
MAR.	48	33	9	1	12	56	36	13	2	9
APR.	56	39	13	4	14	63	43	17	6	11
MAY	64	46	18	8	15	70	50	21	10	14
JUNE	70	52	21	11	14	78	56	26	13	12
JULY	74	56	23	13	13	83	60	28	16	11
AUG.	73	55	23	13	12	82	59	28	15	10
SEPT.	66	50	19	10	11	75	54	24	12	9
OCT.	55	42	13	6	12	63	46	17	8	11
NOV.	44	34	7	1	12	52	38	11	3	10
DEC.	36	27	2	-3	12	45	31	7	-1	8

Source: Meteorological Office, London

Switzerland is a prosperous country with one of the world's highest standards of living. In spite of limited natural resources, the nation's highly specialized industries are extremely profitable. Switzerland has more jobs than its own people can fill. Workers from other countries make up about a fifth of the Swiss labor force.

Switzerland trades mainly with Western European countries and the United States. The Swiss import more goods than they export. They make up the difference with income from tourism and from banking, insurance, and transportation services to foreign persons or firms.

Natural Resources. Switzerland lacks important deposits of coal, iron ore, petroleum, and other minerals on which heavy industry is based. The country's limited mining activity largely involves salt and such building materials as limestone and sandstone.

Most of the land is too high or too rugged to be good farmland. In addition, the climate is generally better for growing hay and other livestock feeds rather than such crops as wheat and fruit. Crops are raised on only about a tenth of Switzerland's total area, chiefly on the Swiss Plateau. More than 40 per cent of the country consists of meadows or grazing land, much of which can be used only in summer. Forests cover about a fourth of Switzerland.

Switzerland's greatest natural resource is perhaps its rushing mountain rivers. These rivers generate more hydroelectric power per person than those of any other European country except Norway and Sweden. Almost all the power produced in Switzerland is generated at power stations on the rivers.

Manufacturing. Switzerland is one of the most industrialized countries in the world. Its manufacturing industries are based on the processing of imported raw materials into high-quality products for export. To keep the cost of materials and transportation as low as possible, these industries specialize in highly skilled workmanship on small, valuable items. In Switzerland's watchmaking industry, for example, the cost of materials is only about one-twentieth the cost of labor. More than 95 per cent of the watches are exported.

The Swiss make such engineering products as generators and other electrical equipment, industrial machinery, machine tools, precision instruments, and transportation equipment. Other major products are chemicals, paper, processed foods including cheese and chocolate, and silk and other textiles.

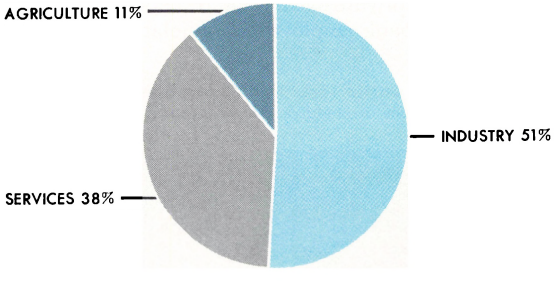
Most Swiss factories are small or medium-sized, because of the stress on quality goods rather than mass production. In addition, hydroelectric power is widely distributed. For these reasons, there are factories in small towns and even in villages throughout the country. The use of hydroelectricity, rather than coal or oil, to power the factories and railroads helps keep the busiest industrial centers almost free of smoke.

Agriculture in Switzerland supplies only about three-fifths of the people's needs. The rest of the nation's food must be imported. Livestock raising is the most important agricultural activity because of the limited cropland resources and the climate. It provides about 75 per cent of Switzerland's farm income, largely through dairy farming. Farmers also raise hogs, goats,

Alan Band Associates

Switzerland's Watchmaking Industry is world famous. Almost all Swiss watches are exported to other countries.

SWITZERLAND'S LABOR FORCE IN 1960



Workers by Economic Activities

Economic Activities	Labor Force: Number of Persons	Labor Force: Per Cent of Total
Manufacturing	999,555	40
Other Services	479,550	19
Trade & Financial Institutions	346,215	14
Agriculture, Forestry, & Fishing	280,191	11
Construction	239,454	10
Transportation & Communication	135,078	5
Utilities	21,758	1
Mining	6,483	*
Unemployed	4,127	*
Total	2,512,411	100

*Less than 1 per cent
Source: *Year Book of Labour Statistics, 1968*, ILO

and sheep. Most of the dairy cattle graze on the high mountain pastures in summer, and are brought down to the valleys in winter. Much of the milk is used to make cheeses for export. These cheeses include Emmentaler, also known as *Swiss cheese*, and Gruyère, which are sold in all parts of the world.

Swiss farms are small, averaging only 8 acres (3 hectares). Farmers work the land carefully to make it as productive as possible. Crops include fruits, wheat and other grains, and potatoes. Grapes are grown near Lakes Geneva, Lugano, and Maggiore, and in other sunny areas. Olive trees are cultivated in the canton of Ticino.

Tourism. Since the early 1800's, increasing numbers of tourists have come to Switzerland. Today, more than $5\frac{1}{2}$ million tourists from all parts of the world visit the country yearly. The busy tourist industry adds over $350 million to Switzerland's annual national income.

Switzerland has thousands of hotels and inns for tourists. Sports centers in the Alps, including Davos and St. Moritz, attract many vacationers. Skiing is especially popular. Most of the ski runs are free of trees because they are higher than the elevation at which trees stop growing. In summer, guides take tourists mountain climbing. Many visitors come for the healthful clear, dry, mountain air, as well as to enjoy the beauty of the Alps. Water sports on Lake Geneva and other lakes are also popular vacation attractions.

Banking adds more than $150 million a year to the national income. Swiss banks attract deposits from people in many countries. The banks are probably the safest in the world, partly because of the nation's neutrality. A depositor can choose to be identified by a number known only to himself and a few bank officials. In this way, a private fortune can be kept secret. Under Swiss law, a bank employee who violates this secrecy may be fined and imprisoned. But the secrecy may be broken in the investigation of Swiss criminal cases.

Transportation. Switzerland has fine transportation systems in spite of the mountains, which make travel difficult. The government owns and operates almost the entire 3,150-mile (5,070-kilometer) railroad network. Many railroad tunnels cut through the Alps, including the Lötschberg, St. Gotthard, and Simplon tunnels. The 12.3-mile (19.8-kilometer) Simplon Tunnel is the longest railroad tunnel in the world.

Switzerland has over 30,000 miles (48,000 kilometers) of hard-surfaced roads and highways. They provide travel even to mountain areas. But roads that wind through the higher mountain passes are open only a few months of the year. Heavy snow makes them unusable except in summer. The $3\frac{1}{2}$-mile (5.6-kilometer) Great St. Bernard Tunnel, opened in 1964, was the first automobile tunnel through the Alps. It links Switzerland and Italy.

The Rhine River connects Basel, Switzerland's only port, with the North Sea. Large barges can reach Basel, which handles about 8 million short tons (7.3 million metric tons) of cargo a year.

Geneva and Zurich have international airports. The privately owned Swissair, Switzerland's only international airline, flies to about 40 countries.

Communication. Switzerland has more than 450 newspapers. The largest daily newspaper, *Der Blick* of Zurich, has a daily circulation of about 190,000. Over half the more than 100 dailies are published in German, and the others are in French or Italian. A few of the nondaily newspapers are in Romansh.

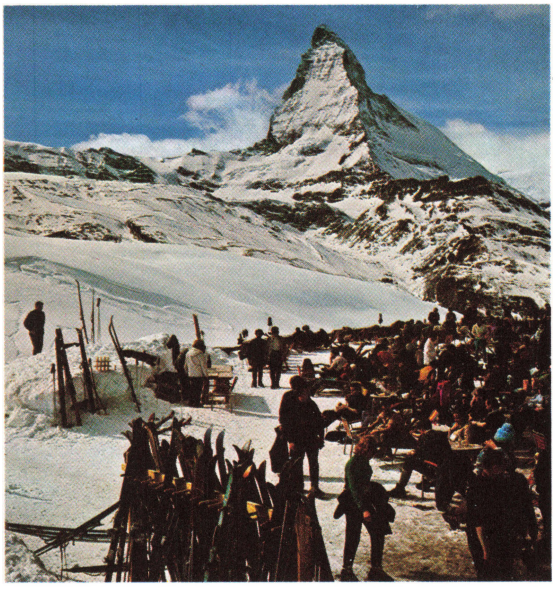
The Swiss government owns the country's three radio stations and three television stations. Each broadcasts in one of the three official languages. A few programs are in Romansh. The government operates the postal, telegraph, and telephone services.

Raising Dairy Cattle ranks high among Swiss farming activities. Cattle auctions are held on Sundays during the summer.

Thomas Hollyman, Photo Researchers

Skiing Tourists flock to the snowy Swiss Alps. One popular ski resort is Zermatt, near the majestic Matterhorn, *rear*.

George Holton, Photo Researchers



Early Days. Before the time of Christ, a Celtic people called the *Helvetians* lived in what is now Switzerland. They were conquered in 58 B.C. by Roman armies led by Julius Caesar. The region, known as *Helvetia*, became a Roman province. By the A.D. 400's, two Germanic tribes, the Alemannians and the Burgundians, settled there. Another Germanic people, the Franks, defeated these tribes by the early 500's. The Frankish kingdom later expanded and became powerful under Charlemagne, but it broke apart during the 800's. See FRANK.

Most of present-day Switzerland became part of the Holy Roman Empire in 962, when the empire began, and the rest was part of the kingdom of Burgundy. That part came into the empire in 1033. Switzerland consisted of many territories, towns, and villages ruled by local lords, and some communities directly under the emperor. See HOLY ROMAN EMPIRE.

The Struggle for Freedom. By the 1200's, the Hapsburg, or Habsburg, family had gained control over much of Switzerland. The free men of what are now the *cantons* (states) of Schwyz and Uri feared the growth of the Hapsburgs' power. In 1273, Rudolf I became the first Hapsburg to rule the Holy Roman Empire. He began to take control of the two regions. In 1291, Schwyz and Uri decided to fight for freedom. They invited the nearby region of Unterwalden to join them.

Leaders of the three regions met in August, 1291, and signed the Perpetual Covenant, a defense agreement. They declared their freedom and promised to aid each other against any foreign ruler. The Perpetual Covenant was the start of the Swiss Confederation. The confederation came to be known as Switzerland. It took its name from the canton of Schwyz.

IMPORTANT DATES IN SWITZERLAND

58 B.C. Roman armies under Julius Caesar conquered Helvetia (now Switzerland).

A.D. 400's Germanic tribes occupied Helvetia.

962 Most of what is now Switzerland became part of the Holy Roman Empire.

1291 Three Swiss *cantons* (states) signed the Perpetual Covenant, which established the Swiss Confederation.

1315-1388 Switzerland defeated Austria in three wars of independence.

1499 Switzerland won independence from the Holy Roman Empire.

1515 The Swiss were defeated by the French in Italy, and began their policy of permanent neutrality.

1648 The Holy Roman Empire recognized Swiss independence.

1798 French forces occupied Switzerland and established the Helvetic Republic under their control.

1815 The Congress of Vienna expanded Switzerland to 22 cantons, and restored the old confederation.

1848 Switzerland adopted a constitution that established federal power over the confederation.

1863 The Red Cross was founded in Switzerland.

1874 Constitutional changes increased federal power.

1920 The League of Nations met at its headquarters in Geneva, Switzerland, for its first session.

1958 Basel became the first Swiss city to let women vote in local elections.

1960 Switzerland helped form the European Free Trade Association.

1963 Switzerland joined the Council of Europe.

1968 Geneva became the first Swiss city to have a woman mayor.

1971 Swiss women received the right to vote in national elections.

By an unknown artist from the *Stumpf Chronicle*. Zentralbibliothek, Zurich, Switzerland

The Battle of Sempach was fought in 1386 against the Austrians during the Swiss wars of independence. That battle, won by the Swiss, is shown in a woodcut dating from 1548.

The Hapsburgs ruled Austria, and the Swiss fought several wars of independence against Austrian forces. In 1315, at Morgarten, Swiss peasants trapped and defeated an Austrian army 10 times their strength. Between 1332 and 1353, five more cantons joined the Swiss Confederation. The Swiss again defeated the Austrians at Sempach in 1386 and at Näfels in 1388. See HAPSBURG.

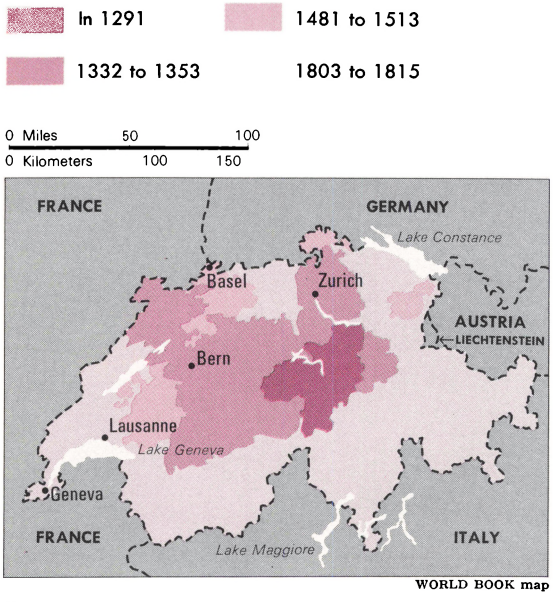
The wars with Austria were full of dramatic incidents, and many famous stories have been told about Swiss heroes. For two exciting tales, see the articles on TELL, WILLIAM and WINKELRIED, ARNOLD VON.

Independence and Expansion. Switzerland became a strong military power during the 1400's. The Swiss entered several wars to gain land, and won many territories. In three battles in 1476 and 1477, the Swiss defeated Charles the Bold, duke of Burgundy. In 1499, they crushed the forces of Maximilian I, the Hapsburg ruler of the Holy Roman Empire. Switzerland won complete independence, though the empire did not officially recognize it until 1648. In 1512 and 1513, the Swiss drove French armies out of northern Italy. Almost all the lands won in these wars of expansion remained under Swiss control for nearly 300 years, and then were admitted into the confederation as cantons.

In 1515, the French defeated the Swiss at Marignano in Italy. The Swiss suffered great losses, and began to question their policy of expansion. Switzerland soon adopted a policy of permanent neutrality, and has stayed out of foreign wars ever since.

Five more cantons joined the Swiss Confederation between 1481 and 1513, making a total of 13. Each canton governed itself as it chose, almost like a separate country. Some cantons were peasant democracies, and others were governed by powerful families or by craftsmen's groups called *guilds*. Many cantons owned nearby territories either by themselves or with other cantons. The confederation had no central government. Delegates from each canton occasionally met in an assembly called the *Tagsatzung* to discuss various matters. But this assembly had no real power.

EXPANSION OF SWITZERLAND—1291 TO 1815



WORLD BOOK map

Religious Civil Wars. The Reformation spread quickly in Switzerland during the early 1500's. Huldreich Zwingli, one of the great leaders of the Protestant movement, preached in Zurich. John Calvin, another great Protestant leader, made Geneva an international center of Protestantism. See REFORMATION.

The Reformation split Switzerland into two armed camps, Protestant and Roman Catholic. The two groups fought in 1529, 1531, 1656, and 1712, but little change in Swiss life resulted.

French Control. In 1798, during the French Revolution, French armies swept into Switzerland and quickly occupied the country. The French set up the *Helvetic Republic*, and gave the new Swiss government strong central power. The Swiss cantons became merely administrative districts of the government.

The great political change caused much confusion and dissatisfaction among the Swiss. As a result, Napoleon of France re-established the 13 Swiss cantons in 1803 and created 6 new ones from their territories. He reduced the power of the central government, and restored much of the cantons' self-government.

After Napoleon's final defeat in 1815, the Congress of Vienna gave Switzerland three more cantons that had been under French control (see VIENNA, CONGRESS OF). The old confederation system was largely restored, with the central government having little power. The Congress of Vienna also guaranteed the neutrality of Switzerland. The European powers at the congress recognized Swiss neutrality as being for the good of all Europe. The neutrality of Switzerland has never since been broken.

The Constitution of 1848. By 1830, many Swiss had begun to demand political reforms—including individual rights and freedom of the press—and greater national unity. Governments were overthrown peaceably in some cantons, but rioting occurred in others. The reform movement grew in strength. Seven cantons banded together to oppose the changes, but were defeated in a three-week civil war in 1847.

Switzerland adopted a new constitution in 1848. This constitution set up a representative democracy with a two-house legislature like that of the United States. It established federal power over the confederation and guaranteed religious freedom and other individual rights. The constitution was changed in 1874 to increase the government's powers, especially in military and court matters.

In 1863, Jean Henri Dunant, a Swiss businessman and writer, founded the Red Cross in Geneva. The Red Cross flag was copied from that of Switzerland, with the two colors reversed. See RED CROSS.

Neutrality in the World Wars. World War I began in 1914, and Switzerland immediately declared its neutrality. The fighting nations respected this policy because Switzerland acted in a strictly neutral manner throughout the war. Food imports decreased during the four years of fighting, but Swiss farmers increased their grain production to feed the people. In 1920, Geneva became the headquarters of the newly created League

Hans Steiner, Black Star

Thousands of Refugees from War-Torn Countries found a haven in neutral Switzerland during World War II.

of Nations, an association of countries organized to prevent war. Switzerland was one of the original members of the League. See LEAGUE OF NATIONS.

After World War II began in 1939, Switzerland again declared its neutrality. German forces did not invade Switzerland. They feared the Swiss would blow up transportation tunnels in the Alps if they did. Switzerland became a major supply link between Germany and its ally Italy. It also represented the United States and other Allied nations in enemy countries. During the war, Switzerland cared for more than 100,000 refugees from a number of countries.

Switzerland did not join the United Nations (UN), which was founded after World War II ended in 1945. The Swiss felt that UN membership, which requires possible military action by member nations, would violate their neutrality policy. But the UN made Geneva its European headquarters, and Switzerland joined most of the UN's specialized agencies.

Switzerland Today still avoids membership in international organizations that might endanger its neutrality—but not so strictly as in the past. Many Swiss, especially young people, have begun to question their nation's policy of neutrality. In 1960, the Swiss helped form the European Free Trade Association, an economic organization of seven nations. Switzerland also joined the Council of Europe in 1963. This organization of 18 countries seeks to promote closer unity among its members for economic and social progress, but it has no real power.

As a neutral country, Switzerland represents about 20 nations in countries with which those nations have broken diplomatic relations. For example, it represents 10 nations, including the United States, in Cuba.

A movement to gain political rights for women has made significant progress in Switzerland. In 1958, Basel became the first Swiss city to allow women to vote in local elections. The next year, Vaud became the first canton to grant that right. In 1968, Geneva became the first Swiss city to have a woman mayor. In 1971, Swiss men voted to give women the right to vote in national elections.

HEINZ K. MEIER and NORMAN J. G. POUNDS

SWITZERLAND / *Study Aids*

Related Articles in WORLD BOOK include:

BIOGRAPHIES

Agassiz (family)
Ansermet, Ernest
Barth, Karl
Bernoulli (family)
Calvin, John
Dunant, Jean H.
Dürrenmatt, Friedrich
Euler, Leonhard
Frisch, Max
Gallatin, Albert
Graf, Urs
Hesse, Hermann
Jung, Carl G.
Karrer, Paul
Keller, Gottfried
Klee, Paul
Kocher, Emil T.
Le Corbusier
Mueller, Paul
Paracelsus, Philippus A.
Pestalozzi, Johann H.
Piaget, Jean
Piccard (brothers)
Reichstein, Tadeus
Rousseau, Jean Jacques
Spyri, Johanna
Tussaud, Marie G.
Winkelried, Arnold von
Wyss (family)
Zwingli, Huldreich

CITIES

Basel
Bern
Geneva
Interlaken
Lausanne
Lucerne
Saint Moritz
Zurich

PHYSICAL FEATURES

Alps
Engadine
Grand Dixence Dam
Jungfrau
Jura
Lake Constance
Lake Geneva
Lake Lugano
Lake of Lucerne
Lake of Thun
Lötschberg Tunnel
Matterhorn
Saint Bernard Passes
Saint Gotthard Pass
Saint Gotthard Tunnel
Simplon Pass and Tunnel
Staubbach

OTHER RELATED ARTICLES

Chillon
Clothing (Traditional Costumes)
Doll (color picture)
Europe, Council of
European Free Trade Association
European Monetary Agreement
Helvetian
Lake Dwelling
League of Nations
Tell, William

Outline

I. Government
II. People
- A. Population
- B. Language
- C. Religion
- D. Education
- E. Arts
- F. Sports

III. The Land
- A. The Jura Mountains
- B. The Swiss Plateau
- C. The Swiss Alps
- D. Rivers

IV. Climate
V. Economy
- A. Natural Resources
- B. Manufacturing
- C. Agriculture
- D. Tourism
- E. Banking
- F. Transportation
- G. Communication

VI. History

Questions

What are the three official languages of Switzerland?
Where does the name *Switzerland* come from?
How much of Switzerland do the Alps cover?
What is the longest railroad tunnel in the world?
Why has Switzerland not joined the United Nations?
How did the Swiss Confederation start?
When did Swiss women receive the right to vote in national elections?
In what region of Switzerland do about two-thirds of the people live?
How does Switzerland keep itself prepared for military defense?
Why are Swiss industrial areas almost free of smoke?

Reading and Study Guide

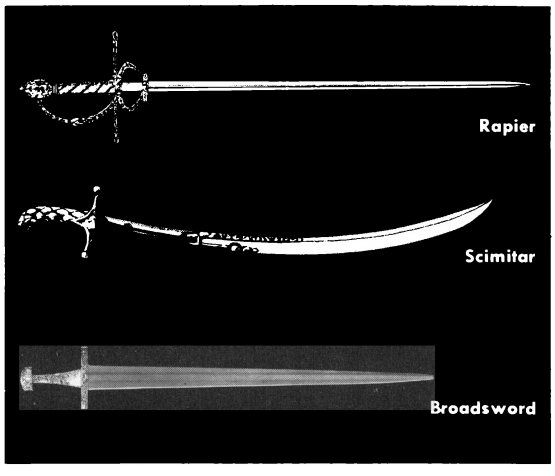
See *Switzerland* in the RESEARCH GUIDE/INDEX, Volume 22, for a *Reading and Study Guide*.

SWORD, *sohrd,* is one of the oldest of all fighting weapons. Man turned his skill to the art of making weapons almost as soon as he discovered the art of working metals. The earliest swords we know about were those of the Assyrians, Gauls, and Greeks. Their swords were short, two-edged weapons made of bronze. The Roman sword was a short, straight, steel weapon with a sharpened point and two cutting edges.

The *broadsword* is a broad-bladed, single-edged short sword, made for cutting but not for stabbing. The broadsword was once used by regiments of cavalry and Highland infantry in the British army. It was better for attack than defense. The *claymore,* a kind of broadsword, but double-edged and longer, was the national weapon of the Highlanders. The favorite weapon of the East was the *scimitar,* a blade with a decided curve, for which Damascus was noted. Toledo, Spain, made fine swords. The *rapier,* used in the 1500's and 1600's, was a straight two-edged sword, with a narrow, pointed blade. Swords used by cavalry during the 1800's were from $2\frac{1}{2}$ to 3 feet (76 to 91 centimeters) long and weighed about $2\frac{1}{2}$ pounds (1.1 kilograms). The sword gave way to the saber in the United States Army. The saber was made for both cutting and thrusting.

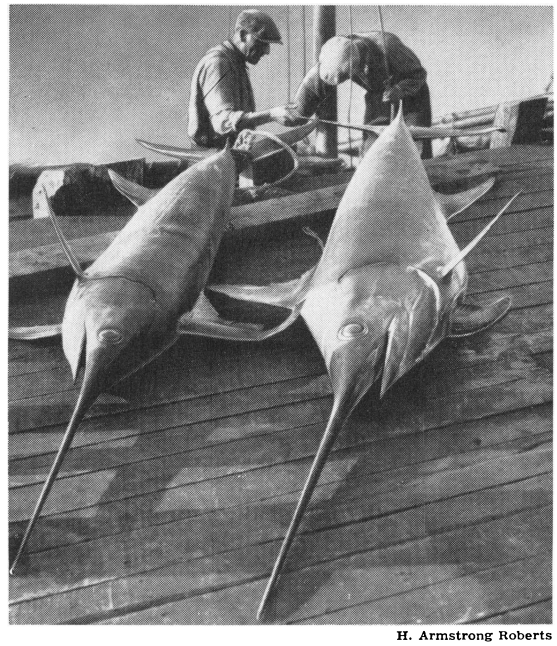
There was less cavalry action in World War I and little chance to use swords. A better weapon for the charges of foot soldiers was the bayonet. This weapon was a blade 1 foot (30 centimeters) or longer attached to the end of the rifle. The sword was also of little use in World War II, when the cavalry units were mechanized. JOHN D. BILLINGSLEY

See also BAYONET; DAGGER; DUEL; FENCING.



SWORD OF DAMOCLES. See DAMOCLES.

SWORDFISH is a large ocean fish with a long, rounded body. It has a long, flattened upper jaw that looks like a sword. The swordfish is given its name because of its jaw. This fish closely resembles the marlins and sailfish, but differs from them because it has a short-based back fin. The swordfish lives in all warm seas. Its average length is 7 feet (2 meters), and it usually weighs about 250 pounds (113 kilograms). Specimens that weigh nearly 1,200 pounds (544 kilograms) and measure as long as 15 feet (4.6 meters) have been caught. Swordfish are highly regarded by big-game fishermen. The swordfish is hard to catch because hooks pull out of its tender mouth easily. It is also difficult to get swordfish to take the bait.



H. Armstrong Roberts

Swordfish Travel in Pairs during breeding season, and a fishing boat will often hook two of the leaping, speeding sword-nosed fighters. Heavy line and a strong pole are needed for the thrilling, backbreaking fight with a "sword."

Their "swords" are sharp-edged and strong, and half as long as the body. There have been several instances of swordfish charging boats and piercing the hulls.

Commercial fishermen catch swordfish by harpooning them from a pulpit on the bow of a sailboat. The flesh is coarse, but it has a good flavor when cut and cooked as a steak. Swordfish eat squid and menhaden, herring, mackerel, and other fish that travel in schools.

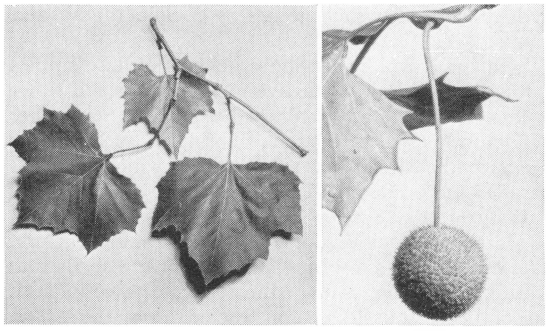
In 1971, the U.S. Food and Drug Administration (FDA) advised the public not to eat swordfish. The agency found that almost all the swordfish sampled contained the mineral mercury in amounts that exceeded safety levels. Scientists have not determined the sources of the mercury, but they believe that some of it comes from industrial wastes.

Two other kinds of fish have pointed, bony spikes much like those of the swordfish. The *marlins* have a long-based but low dorsal fin along the back. The *sailfish* has a long, high, sail-like fin along its back.

Scientific Classification. The swordfish belongs to the swordfish family, *Xiphiidae.* It is classified as genus *Xiphias,* species *X. gladius.* LEONARD P. SCHULTZ

See also MARLIN; SAILFISH; FISH (picture: Fish of Coastal Waters and the Open Ocean).

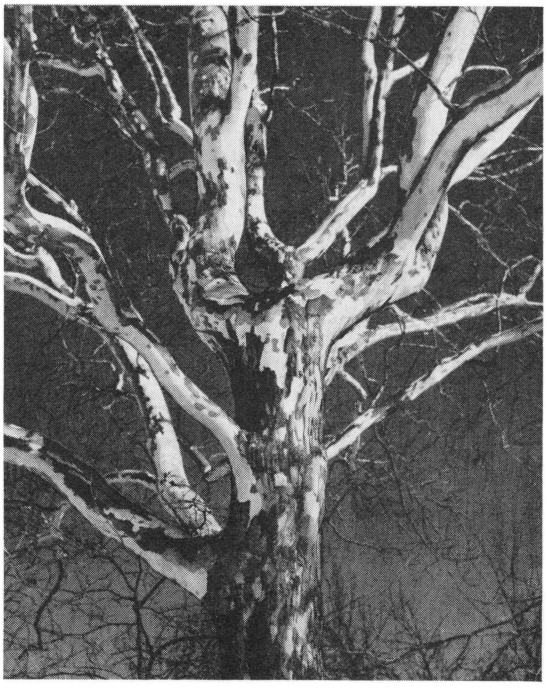
SYCAMORE is a shade tree with reddish-brown wood. It grows in fertile lowlands and along streams. It is found in great numbers in the United States from southern Maine to Nebraska and as far south as Texas and Florida. The tree may reach a height of 175 feet (53



George J. Baetzhold

Sycamore Leaves, *above left,* are broader than they are long. The fruit of the sycamore tree, *above right,* is a round ball. Its bark, *below,* does not stretch as much as the bark of other trees. As the tree grows, some bark breaks off leaving exposed patches.

Rutherford Platt



meters) and be 14 feet (4 meters) through the trunk. The bark on the lower trunk is reddish-brown, and the bark on the branches is olive-green. The bark on the branches breaks off in tiny scales. When these scales break off, they show an inner bark that is light cream in color. This light bark gives rise to the phrase "hoary-antlered sycamore." Some sycamores are known as *buttonwoods*, others as *plane trees*.

The sycamore tree can be recognized by its leaves, which are broad and have large teeth. The stem of each leaf is hollow at the base where it encloses the next year's bud. The flowers of the sycamore are of two types, those that bear *stamens* and those that bear *pistils*. Each type of flower grows in separate flower heads on different parts of the same tree. The fruits of the sycamore are borne in small balls which hang from drooping stems. Each ball is made up of many tiny dry fruits which are tightly packed together. The fruits are known as *achenes*.

Scientific Classification. Sycamores belong to the plane tree family, *Platanaceae*. They make up the genus *Platanus*. The most common sycamore tree is *P. acerifolia*.

WILLIAM M. HARLOW

See also LEAF (picture: Kinds of Tree Leaves); TREE (Familiar Broadleaf and Needleleaf Trees [picture]).

SYDENHAM, *SIHD'n um,* **BARON** (1799-1841), CHARLES EDWARD POULETT THOMSON, was a British statesman and governor general of Canada from 1839 to 1841. He succeeded Lord Durham in Canada, and carried through the unification of Upper and Lower Canada. He was born at Wimbledon, England, and worked as a merchant. In 1826 he was elected to Parliament and in 1834 became president of the Board of Trade.

JAMES L. GODFREY

SYDENHAM, THOMAS (1624-1689), an English physician, believed and taught that medicine could be learned only at the bedside of the patient. He was a keen observer, and gave excellent descriptions of gout, scarlet fever, measles, and influenza. He had great faith in the healing power of nature, and he felt that fever was nature's way of fighting the injurious matter that caused disease.

Sydenham was born at Wynford Eagle, Dorset, and received his degree from Oxford University. Success came slowly to him, but eventually he gained recognition as one of the great doctors of his time.

Sydenham prided himself on being a practical physician, and he avoided all theory. He was not interested in the developing sciences of anatomy, physiology, and chemistry, and felt that they were of little use to the practicing doctor. His practical bent is shown by his adoption of quinine for the treatment of fevers, at a time when many doctors opposed this new drug.

Even though he avoided theory, Sydenham developed a theoretical explanation of the origin and spread of epidemics. He believed that changes in the atmosphere acted on ordinary diseases at various times and made them more virulent so that they attacked many people rapidly. This theory was accepted by many physicians for several hundred years.

GEORGE ROSEN

SYDNEY (pop. 2,717,069) is Australia's oldest and largest city and the capital of the state of New South Wales. The city lies on a huge, deep harbor on the southeastern coast (see AUSTRALIA [political map]). This harbor, called Port Jackson, or Sydney Harbour, has made Sydney Australia's busiest seaport. Sydney also ranks as the nation's leading industrial city.

The British founded Sydney as a prison colony in 1788. At that time, many nations sent criminals to distant prison colonies. The colony's first governor, Captain Arthur Phillip, chose the site for its harbor and supply of fresh water. He named it for the British statesman Thomas Townshend, Viscount Sydney.

The City and its suburbs cover about 670 square miles (1,740 square kilometers). Downtown Sydney lies on the south side of Sydney Harbour. The oldest section of the city, an area called the Rocks, lies near the waterfront. In the 1960's, a state redevelopment project restored many historic structures of the Rocks. Before British settlement, this area had many rock formations.

George Street, the city's main street, runs through

the center of downtown Sydney. Australia Square Tower, the nation's tallest building, rises 565 feet (152 meters) from George Street. East of the downtown area lies a series of parks, including Hyde Park, the Domain, and the Royal Botanic Gardens. Still farther east is a section called Kings Cross, which includes many nightclubs and restaurants.

The names of many buildings and places in Sydney are reminders of the city's days as a prison colony. Hyde Park Barracks, now Sydney's court building, originally housed male convicts. An island in Sydney Harbour is called Pinchgut because it served as a prison where the inmates often went hungry.

Sydney Harbour Bridge links downtown Sydney with the suburbs on the north shore (see BRIDGE [picture: Steel-Arch Bridge]). Other suburbs spread east, south, and west of the city. Two large recreation areas—Royal National Park and Ku-Ring-Gai Chase—lie just outside the Sydney metropolitan area.

The People of Sydney are called *Sydneysiders*, and most of them have British ancestors. But thousands of other Europeans have settled in the city since the mid-1900's. Sydney also has a few thousand *aborigines*, the descendants of the first people who lived in Australia.

Most Sydney families own a house and garden in one of the suburbs. However, the number of people living in apartments has increased since about 1960 because of the rising cost of land. Sydney has almost no slums, but some aborigines live in substandard housing.

The city's mild climate enables Sydneysiders to spend much time outdoors during most of the year. On weekends, thousands of them sail, surf, swim, or water-ski. Sydney has more than 30 beaches, including such famous surfing beaches as Bondi and Manly. Many of the Sydneysiders play such games as cricket, rugby, and tennis.

Sydney's Royal Easter Show, held in April, resembles a huge county fair, with livestock judging and other events. The Waratah Festival takes place in September or October, during Australia's spring season. Flowers decorate the streets for this festival, which includes parades and outdoor concerts.

Cultural Life. Sydney's Opera House, completed in 1973, includes facilities for concerts, opera, and theater. The building has towering, white concrete shells that resemble billowing sails. Many architects consider it one of the finest buildings constructed during the 1900's.

The city has three universities—Macquarie University, the University of New South Wales, and the University of Sydney. The Public Library of New South Wales owns a huge collection of books and documents about Australia. The Art Gallery of New South Wales displays works by leading Australian and European artists.

Economy. Sydney manufactures goods worth more than half the total value of those made in New South Wales. The value of Sydney's production totals almost a third of that of Australia. The city's chief factory products include automobiles, clothing, food products, and textiles. More than 15,000 plants employ over a million workers. Rich cattle- and sheep-raising areas in New South Wales make Sydney an important livestock and wool market as well. Sydney also serves as the banking and business center of New South Wales.

The city is sometimes called the *gateway to Australia*. Most visitors to the country enter through Sydney. Sydney's Kingsford Smith International Airport ranks as the nation's busiest. Sydney Harbour serves about 4,000 ships and handles about 10 million short tons (9.1 million metric tons) of cargo yearly. The city's

Qantas Airways

Sydney, the largest city of Australia, also ranks as the country's leading seaport and industrial center. Sydney lies on the southeast coast of Australia, on a deep harbor. The Sydney Opera House, *foreground,* is a landmark of the city.

chief exports include coal, meat, wheat, and wool.

History. Sydney received its first shiploads of convicts—about 750 men and women—on Jan. 26, 1788. The prison colony grew slowly at first because the convicts knew little about building or farming. About 1800, a farmer named John Macarthur brought the first Merino sheep to the area. This breed created a successful wool industry that attracted many free settlers. By 1842, the population had grown to about 30,000. Sydney was incorporated as a city that year.

In 1848, Great Britain stopped sending convicts to Sydney, but the rich farmland of the area continued to attract settlers. A prospector discovered gold in New South Wales in 1851, and Sydney grew rapidly during the gold rush that followed. By 1891, the population had risen to 383,000.

The city continued to grow steadily during the 1900's. Its population increased to more than a million by the late 1920's, and to nearly 3 million by the mid-1970's. Many problems resulted from this rapid growth. As skyscrapers replaced older buildings, for example, downtown streets became increasingly crowded. The people started to show concern about the smog and water pollution created by the many factories in the area. In addition, only about 85 per cent of Sydney's homes had sewers. The remaining 15 per cent dumped their sewage into underground tanks called septic tanks. Such tanks sometimes pollute water supplies. In the mid-1970's, the government began to provide financial aid to help expand the sewage system. GAVIN SOUTER

See also AUSTRALIA (pictures).

SYDNEY, Nova Scotia (pop. 33,230), is a steel center and the third largest city in Nova Scotia. It lies in a coal-mining region on Cape Breton Island, about 210 miles (338 kilometers) northeast of Halifax. For location, see NOVA SCOTIA (political map). Sydney is the island's main railway terminal. Steamship lines connect the city with major world ports. Sydney was founded in 1785. It was named for Lord Sydney, a secretary of state for the colonies. For the monthly weather in Sydney, see NOVA SCOTIA (Climate). THOMAS H. RADDALL

SYENITE, *SY uh nyt*, is an igneous rock with a grainy texture, which is sometimes mistaken for granite. It is formed by the cooling and solidifying of molten material.

SYLLOGISM. See LOGIC (Deductive Logic).

SYLVESTER is the name of two popes of the Roman Catholic Church.

Sylvester I (?-335), SAINT SYLVESTER, reigned as pope from 314 until his death. According to legend, he healed the Roman emperor, Constantine the Great, of leprosy, and also baptized him. It is certain that Constantine built the basilicas of Saint John Lateran and of Saint Peter in the Vatican while Sylvester was pope. Sylvester was born in Rome.

Sylvester II (950?-1003) was the first Frenchman to become a pope. He reigned from 999 until his death. His ambition was to unite all western Europe into one church and one state. Sylvester was born probably in Aurillac, and was educated in the monastery of Aurillac in Auvergne. He studied mathematics, astronomy, and dialectic. GUSTAVE WEIGEL and FULTON J. SHEEN

SYLVITE. See POTASH.

SYMBIOSIS, *SIHM by OH sihs*, means *living together*. Any two, different organisms that live together are symbiotic, whether they benefit one another, harm one another, or have no effect at all. The term is often restricted to the idea of mutual benefit. There are three forms of symbiosis: parasitism, commensalism, and mutualism.

In *parasitism*, one organism obtains food and shelter at the expense of another, sometimes destroying the host. An excellent example of parasitism is the hookworm that may live in the intestines of human beings and other animals. See PARASITE.

In *commensalism*, one organism obtains "crumbs" left over from the host's food, and is sheltered by the host. Little, if any, harm is done. For example, the remora attaches itself to the bodies of sharks and sea turtles. It gets free transportation and protection. When the hosts kill prey, the remoras detach themselves to gobble tidbits too small for the hosts (see REMORA).

In *mutualism*, both parties benefit. Man has a mutualistic relationship with his food crops and livestock. Mutualism occurs naturally when an alga and a fungus grow together to form a lichen which differs from either plant. Each organism benefits from this close association. The fungus, which cannot produce its own food, gets its food from the alga. The alga gets protection from the fungus. See LICHEN. C. BROOKE WORTH

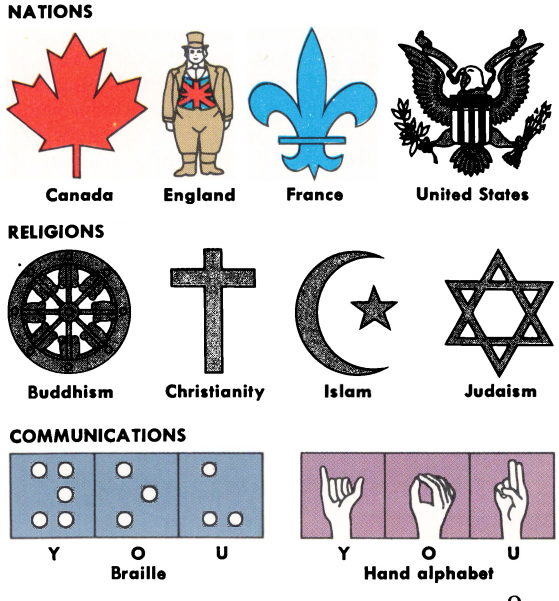
SYMBOL is anything that communicates a fact or an idea or that stands for an object. Some symbols, such as flags and stop signs, are visual. Others, including music and spoken words, involve sounds. Symbols rank among man's oldest and most basic inventions.

Almost anything can be a symbol. For example, the letters of the alphabet are among the most important symbols because they form the basis for almost all

SYMBOLS

A symbol is a sign that stands for an idea or an object. Nations and religions use a variety of pictorial symbols to identify themselves and to express their ideals. The letters of the alphabet are symbols for sounds. People combine letters to form words that also represent ideas and objects. The illustrations in the bottom row show how words can be communicated to blind or deaf people.

WORLD BOOK illustrations by Mas Nakagawa



written and spoken communication. Gestures and sounds made by human beings also symbolize ideas or feelings. A symbol can be used alone or in combination with other symbols.

Uses of Symbols. Individuals, nations, and organizations use symbols every day. Symbols also play an important part in religious life. People throughout the world have agreed on certain symbols that serve as a shorthand for recording and recalling information. Every branch of science, for example, has its own system of symbols. One of these branches, astronomy, uses a set of ancient symbols to identify the sun, the moon, the planets, and the stars. In mathematics, Greek letters and other symbols make up an abbreviated language. Other symbols appear in such fields as commerce, engineering, medicine, packaging, and transportation. Since the 1930's, many nations have been working together to create a system of road and traffic signs that could be universally understood.

All countries have official or unofficial national symbols. A flag, a national anthem, or a national ruler may symbolize a nation. Familiar symbols of the United States also include Uncle Sam and the Statue of Liberty. National symbols for other countries include the maple leaf for Canada, John Bull for Great Britain, and the bear for Russia. Many political parties use symbols for identification. In the United States, a mule symbolizes the Democratic Party, and an elephant represents the Republican Party.

Most religions use symbols to represent their beliefs. The cross symbolizes not only the death of Jesus Christ, but all Christian beliefs. The Star of David represents the teachings of Judaism.

The armed forces of a nation use symbols to identify their various branches and the rank of each serviceman and servicewoman. Artists and writers often use certain colors, images, or words to express ideas symbolically.

Many rituals have a symbolic nature. Such symbolic acts include coronations, inaugurations, military salutes, and religious sacraments.

Symbols with Different Meanings. Several societies may use the same symbols, but these symbols may stand for different things. In many societies, for example, the color red symbolizes war and violence. But this color also has other meanings. In China, red represents marriage. Among American Indians, it stands for the East. Red symbolizes life in the Shinto religion of Japan, but in France it represents law schools.

A symbol has only the meaning that people have given it. Even a powerful symbol can lose its meaning if the society dishonors or ignores it for a period of time. Throughout early history, many people considered the swastika a good luck charm. But in 1920, the Nazi Party of Germany adopted it as its symbol. The swastika came to represent the Nazi attempt to conquer Europe. Today, it ranks as one of the most hated symbols in history. WHITNEY SMITH

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Element, Chemical (tables)
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Insignia
Liberty Cap
Map (Symbols)
Mythology (Mythical Symbols)
Ranching (picture)
Seal
Shorthand
Swastika

SYMBOLIC LOGIC. See LOGIC; SET THEORY (History).

SYMBOLISM is a literary movement started by a group of French poets between 1885 and 1895. Stéphane Mallarmé led the movement, but the poetry of Paul Verlaine was more widely imitated. Leading theorists of symbolism included René Ghil, Gustave Kahn, Jean Moreás, and Charles Morice. Many European poets of the early 1900's followed the symbolist style.

Symbolism gave a spiritual atmosphere to the world by attributing to it a sacred, mystical quality. This central idea comes from the philosophy of Emanuel Swedenborg, a Swedish religious leader. According to him, visible realities are symbols for the invisible world of the spirit. In his sonnet "Correspondences," French poet Charles Baudelaire pictured man as walking in "a forest of symbols" which speak to him in words he cannot quite understand.

Symbolist verse usually presents a poetic image that can be interpreted many ways. The symbolists searched for the musical quality in words. They expressed themselves in metaphors and created technical modifications in existing verse forms. Some critics have called the movement decadent because of its obsession with death and its general pessimism. ANNA BALAKIAN

See also DRAMA (Modern); MALLARMÉ, STÉPHANE; RUSSIAN LITERATURE (Symbolism); VERLAINE, PAUL.

SYMINGTON, STUART (1901-), a Missouri Democrat, has been a United States senator since 1953. In 1960, Symington was a leading candidate for the Democratic presidential nomination.

As a member of the Senate Armed Services and Foreign Relations committees, Symington specializes in military affairs. In 1954, he charged that the Department of Defense had wasted millions of dollars on outdated weapons. He became a leading critic of U.S. involvement in the Vietnam War.

William Stuart Symington was born in Amherst, Mass. In 1918, he served a year in the Army during World War I. He graduated from Yale University in 1923. He held management positions in several companies and then became president of the Emerson Electric Manufacturing Company in 1938. In 1945, President Harry S. Truman appointed him chairman of the Surplus Property Board. Symington became assistant secretary of war in 1946 and was the first secretary of the air force from 1947 to 1950. WILLIAM J. EATON

SYMMETRY, *SIHM uh tree,* means equal or balanced proportions. Man and many animals have symmetrical proportions. For example, a line from a man's nose to the ground would divide him into two equal parts. This is called *bilateral symmetry.* Some animals, such as the starfish, have the symmetry of a wheel. This is called *radial symmetry.*

SYMPHONIC POEM, *sim FAHN ik,* is a fairly long orchestral work in one movement, usually built upon a story. Many symphonic poems follow the form of *sonata-allegro* movements as developed in symphonies, but they are predominantly emotional and dramatic in content. A number of composers who used the free form of

symphonic poems developed the *leitmotiv* (repeated short melodic phrase or passage) as a means of unifying the work. The symphonic poem form became popular in the middle 1800's. Franz Liszt and Richard Strauss are noted for their symphonic poems. GRANT FLETCHER

See also STRAUSS, RICHARD.

SYMPHONY, *SIM fuh nee*, is a form of music written for orchestra in which composers present their most highly organized and expressive musical ideas. The standard pattern of four movements usually includes a fast movement, a slow one, a dance form, and a final movement, usually fast. In classical symphonies, these four movements are often a *sonata-allegro* form; a *three-part song* form; a *minuet* and a *trio;* and a *rondo*.

Joseph Haydn began the formal experimentation that developed the symphony. His ideas were expanded by later composers, principally Wolfgang Amadeus Mozart, Ludwig van Beethoven, and Johannes Brahms. Haydn and Mozart wrote *classic* symphonies developed from the earlier *sinfonia*, a short orchestral interlude. These works followed a set pattern. Beethoven made several changes in developing the *romantic* symphony, following a sonata-allegro with a large song form, a *scherzo*, and a rondo or another sonata-allegro.

As the power and size of the symphony orchestra developed, symphonic compositions became more complex. Peter Ilich Tchaikovsky and Brahms constructed larger and longer forms, and sometimes mixed the basic forms or switched the order of movements. Anton Bruckner and Gustav Mahler wrote huge *post-Wagnerian* symphonies. Composers today often write short symphonies, or write only for chamber orchestras.

Significant developments include *cyclic* forms, in which a single theme binds each movement together; *single movement* forms, in which the symphonic plan is condensed into one movement; and *symphonic suites*, or loosely constructed works of symphonic proportions. Few new ideas have gone beyond the basic forms developed by the German masters. GRANT FLETCHER

See also MUSIC (Orchestral Music; History); ORCHESTRA; SONATA.

SYMPOSIUM is a discussion of a subject by a group of persons. Each of the speakers talks about the general subject or a part of it. When the parts are put together, the whole subject is covered.

For example, a symposium might be held on Scouting. Four speakers might talk on the following parts of the subject: (1) The Origin and Development of Scouting; (2) Ideals of Scouting; (3) Results of Scout Training; and (4) Problems Facing Scouting.

The chairman introduces the subject and the speakers. He also directs a question-and-answer period at the end. A symposium usually gives better coverage of a subject and arouses more audience discussion than a single speech. J. V. GARLAND

See also PANEL DISCUSSION.

SYNAGOGUE, *SIN uh gahg*, is a Jewish house of worship. Synagogues are believed to have been started during the Babylonian captivity in the 500's B.C. At the time of Jesus, there were synagogues wherever the Jews had settled. Synagogues also served in early days as law courts and places of religious instruction.

The ancient synagogue was built so that the worshiper, on entering or at prayer, faced in the direction of Jerusalem. The most important articles included the chest, known as the Holy Ark, in which the rolls of Scripture were kept, a lamp that burned all the time to symbolize the presence of God, and candlesticks for use on the Sabbath and festival days. The head of the synagogue was responsible for the conduct of the service. He chose members to lead the prayers, read from the *Torah* (Scriptures), and preached. The congregation was divided by a screen, with the men sitting on one side of it and the women on the other.

The modern synagogue has kept such self-governing features as a board of directors, known in early days as the board of elders. Most synagogues require a quorum of 10 men to begin services. LOUIS L. MANN

See also JEWS (pictures); RHODE ISLAND (picture).

SYNAGOGUE COUNCIL OF AMERICA is the united voice of American Jewry in all matters in which religion plays an important role. It is made up of the six leading national Jewish organizations in the United States, including three rabbinic bodies and three laymen's groups. The Rabbinical Council of America and the Union of Orthodox Jewish Congregations in America represent Orthodox Jews in the Synagogue Council. The Rabbinical Assembly of America and the United Synagogue of America represent the Conservative Jews. The Central Conference of American Rabbis and the Union of American Hebrew Congregations represent the Reform group. The council was founded in 1926 and has headquarters at 432 Park Avenue South, New York, N.Y. 10016. It cooperates with the U.S. government, the United Nations, and Protestant, Catholic, and other groups on social and moral matters.

Critically reviewed by the SYNAGOGUE COUNCIL OF AMERICA

SYNAPSE. See NERVOUS SYSTEM (Nerve Impulses).

SYNCHRO-CYCLOTRON, *SING kroh SYE kloh trahn*, is a *particle accelerator*, or atom smasher, used to produce high-speed nuclear particles. The particles, including protons and alpha particles, are used in nuclear research to bombard the nuclei of atoms.

The synchro-cyclotron is an improved form of the cyclotron (see CYCLOTRON). Both devices are cylindrical machines that use electrical fields to *accelerate* (speed up) the particles. Magnetic fields guide the particles around circular paths. However, the synchro-cyclotron produces much higher energies than the cyclotron. A cyclotron cannot accelerate protons to energies greater than about 25 million electron volts (written 25 mev). A synchro-cyclotron at the University of California produces 740 mev. Russia has a 680-mev machine.

The final energy produced by a cyclotron is limited because above about 20 mev, protons tend to get out of *phase* (step) with the voltage applied as they spiral within the machine. This is due chiefly to an increase in mass resulting from the increased velocity, as explained by the theory of relativity (see RELATIVITY [Special Theory of Relativity]). In 1945, Edwin M. McMillan of the United States and V. Veksler of Russia, working independently, showed that particles could be accelerated to still higher energies by adjusting the frequency of the machine's voltage so that it remained in step with the spiraling particles. The frequency is *synchronized* with the particles, hence the name *synchro-cyclotron*. ROBERT L. THORNTON

See also PARTICLE ACCELERATOR; LAWRENCE, E. O.

SYNCHROTRON, *SIN kroh trahn*, is a machine for accelerating atomic particles to high energies. In a synchrotron, the particles are bent by a magnetic field to move at almost a constant radius inside a vacuum chamber. As the energy increases, the magnetic field must also increase to keep this radius constant.

Synchrotrons can accelerate electrons to many hundred millions of electron volts (Mev). When the electrons strike a target, an intense beam of X rays is produced. These rays have sufficient energy to cause nuclear reactions and to produce mesons. See MESON.

Einstein's theory of relativity states that a particle increases in mass as its velocity rises (see RELATIVITY [Special Theory of Relativity]). The percentage increase in mass of the electrons is much larger than for heavier particles, such as protons. Thus an electron accelerated to 300 Mev has a mass 600 times greater than when it is at rest. Edwin M. McMillan built the first 335-million-electron-volt synchrotron. It was built at the University of California. ROBERT L. THORNTON

See also PARTICLE ACCELERATOR with its list of *Related Articles*.

SYNCLINE, *SING kline*, is the name for the *concave* (down-arched) part of a fold in rock structures. The folds are wrinkles that occurred during the time when the rocks were forming.

SYNCOPE. See ELISION.

SYNDICALISM, *SIN dih kul iz'm*. Syndicalists agree with socialists that it is not safe to trust private owners with the power that comes from ownership of industries and public utilities. They differ from the socialists in that they are equally unwilling to trust government.

There are many kinds of syndicalists, but all agree that force is the basis of society. They believe power should never be centralized, and that general strikes should be used to achieve the ends of their movement.

Syndicalism began in France in 1892. It has made little advance in the world. PAYSON S. WILD

SYNDICATE. See CARTEL; NEWSPAPER SYNDICATE.

SYNECDOCHE. See METONYMY.

SYNGE, *sing*, **JOHN MILLINGTON** (1871-1909), was an Irish dramatist. Most of his plays are set among Irish peasant characters, and are written in a vigorous poetic language based on folk speech.

Synge had a particular genius for tragicomedy. Like other Irish writers of his time in Ireland, he dealt imaginatively with heroism and the apparent gap between the real and the ideal. This gap forms the theme of *In the Shadow of the Glen* (1903), *The Well of the Saints* (1905), and *The Playboy of the Western World* (1907). Synge wrote two tragedies, *Riders to the Sea* (1904) and *Deirdre of the Sorrows* (performed after his death). In both plays, heroism is tied to the central character's confrontation with mortality.

Synge also wrote verse, and sketches of peasant life in the Aran Islands and other parts of Ireland. He was born in Rathfarnam, a suburb of Dublin. MARTIN MEISEL

SYNGE, RICHARD LAURENCE MILLINGTON (1914-), a British biochemist, shared the 1952 Nobel prize for chemistry for the invention of partition chromatography. This is a method for analyzing substances in small samples of complicated mixtures. Each substance in a drop of solution is allowed to move at its own rate when placed on specially prepared filter paper. Then the structure of important large molecules can be inferred. Synge was born in Liverpool.

See also MARTIN, ARCHER J. P.

SYNOD, *SIN ud*, is an assembly, or council, of representatives of a church. It is sometimes composed of both clergymen and laymen. Synods meet for the purpose of discussing and deciding on matters of discipline, faith, and morals. See also PRESBYTERIANS.

SYNODIC MONTH. See MOON (How the Moon Moves).

SYNONYM, *SIN oh nim*, is a word that has the same, or nearly the same, meaning as another word. It comes from two Greek words meaning *associated* and *name*. There are many cases when one word will serve the same purpose as another. For example, *small* boy and *little* boy; *smart* idea and *clever* idea; *kill* a man and *slay* a man. But although two words may be synonymous, or used in the same way, in one sense, they are not synonymous in another sense. For example, *dull* and *stupid* may both be used to describe a person. But one does not use the word *stupid* to describe the *dull* blade of a knife. Synonyms enrich the language by helping the speaker or writer to use words with distinct and definite meanings and associations. They also make it possible to avoid the monotony of repetition. See also ANTONYM.

SYNOVIAL FLUID. See JOINT; KNEE.

SYNTAX, *SIHN taks*, is a description of the way words are put together to make sentences. It describes the order of the subject and verb, the position of auxiliary words and objects, and the relation of modifiers to the words they modify. See SENTENCE.

Word order is not the same in all languages. In English, we say "I gave Jim the ball." In another language, the order might be "I the ball Jim gave." When we put words together in proper order, we are able to express the meaning we intend. "I was shown a book in black leather by the clerk" is a different sentence from "I was shown a book by the clerk in black leather." The meaning has changed because the syntax has changed.

Syntax is one of the four main divisions of linguistics. The others are *phonology*, the study of the sounds of the language; *morphology*, the study of the formation and structure of words; and *semantics*, the study of words' origins, changes, and meanings. Morphology (structure) and syntax (arrangement) are usually considered the main parts of *grammar*. WILLIAM F. IRMSCHER

SYNTHESIS, *SIN thee sis*, means bringing together two or more ideas or elements to form a new unity. In the chemical industry, coal and air and other substances are combined to synthesize nylon. Many persons have spoken of America as a synthesis of different races and nationalities. In philosophy, a combination of many ideas is known as a synthesis. LOUIS O. KATTSOFF

SYNTHESIZER. See ELECTRONIC MUSIC.

SYNTHETICS are man-made substances in which two or more elements are chemically combined to make a new compound. Synthetics include all plastics and such man-made fibers as nylon and rayon.

Manufacturers use synthetics in making countless products for the home and industry. For example, they use tough plastics in furniture, machinery parts, and packaging. Synthetic fibers form part of such products as rubber tires, brushes, electric insulating material, and clothing. Other items that can be made *syn-*

thetically (chemically) include gems and various foods.

Chemists can give synthetics various properties. Some synthetics are brittle and strong, for example, and others are elastic. Many resist chemicals, insects, mildew, and sunlight. In many ways, synthetics are superior to natural products.

Rayon and certain other synthetic fibers are made from cellulose. But manufacturers produce most synthetics by combining such raw materials as carbon, hydrogen, nitrogen, and oxygen. The manufacturers change these raw materials into chemical compounds through one of several chemical processes. The most common process is *polymerization*, which involves converting small molecules into much larger ones (see POLYMERIZATION). After the chemical process has been completed, the synthetic may be formed into fibers, a film, or a liquid that can be molded into various shapes.

Most synthetic substances have been developed when natural products became scarce or inadequate to meet specific industrial needs. For example, chemists developed synthetic rubber because of a shortage of natural rubber. They produced a plastic called *polyester* to meet the needs of shipbuilders, who wanted a more rust-resistant material than metal for the hulls of ships. RICHARD F. BLEWITT

Related Articles in WORLD BOOK include:

Acrilan	Nylon	Rayon
Dacron	Orlon	Resin, Synthetic
Dynel	Paint	Rubber
Fiber (Synthetic Fibers)	Plastics	Silicone
Fiberglass	Plexiglas	Vinyl

SYNTHETISM. See GAUGUIN, PAUL.

SYPHILIS. See VENEREAL DISEASE.

SYR DARYA, *sir DAHR yuh,* is a river that runs from Fergana Valley in Russia to the Aral Sea. The river is 1,370 miles (2,205 kilometers) long. It is important for irrigation but is too shallow to be navigable. See also ARAL SEA.

SYRACUSE, *SIHR uh kyoos,* on the southeastern coast of Sicily, was one of the most powerful cities of the ancient Greek world. Greeks from Corinth founded Syracuse about 734 B.C. The city grew rapidly. It became a cultural center under Hiero I, who built an empire in southern Italy.

A democracy was established at Syracuse after Hiero's death. It defeated a strong Athenian force that besieged the city from 415 to 413 B.C. But internal troubles and threats from Carthage brought to power a harsh military ruler—Dionysius I. After Dionysius' death in 367 B.C., Syracuse declined.

About 345 B.C., the Corinthian general Timoleon defeated the Carthaginians and rebuilt the city. During the rule of Hiero II, in the 200's B.C., Syracuse was allied with Rome. But the city later sided with Carthage, and Romans captured it in 211 B.C., after a three-year siege. The mathematician Archimedes aided the defenders during the siege with several defensive devices he invented (see ARCHIMEDES). Syracuse then became the capital of the Roman province of Sicily. In A.D. 878, the Saracens destroyed Syracuse. The town of Siracusa now stands on its site. DONALD W. BRADEEN

SYRACUSE, N.Y. (pop. 197,297; met. area 636,596), is an important industrial center in the heart of a rich farming region. It was once called *Salt City* because it produced so much salt. The city hosts many state conventions, because it lies near the center of New York.

Location, Size, and Description. Syracuse lies near Onondaga Lake, about 150 miles (241 kilometers) west of Albany, in the lake region of New York (see NEW YORK [political map]). The city covers about 26 square miles (67 square kilometers). Downtown Syracuse centers around Clinton Square and Saint Mary's Circle.

Cultural Life. Syracuse University is the most important educational institution in the city. It includes the facilities of the State University of New York College of Environmental Science and Forestry. Other schools are Le Moyne College (Jesuit), Pebble Hill School, the Manlius School, and the New York State College of Medicine. The Court of Appeals Law Library there has a collection of about 90,000 volumes. The city is the See of the Roman Catholic diocese and state headquarters of the Baptist and Congregationalist churches. The Syracuse Museum of Fine Arts was founded in 1896. It had the nation's first permanent collection devoted entirely to works by American artists.

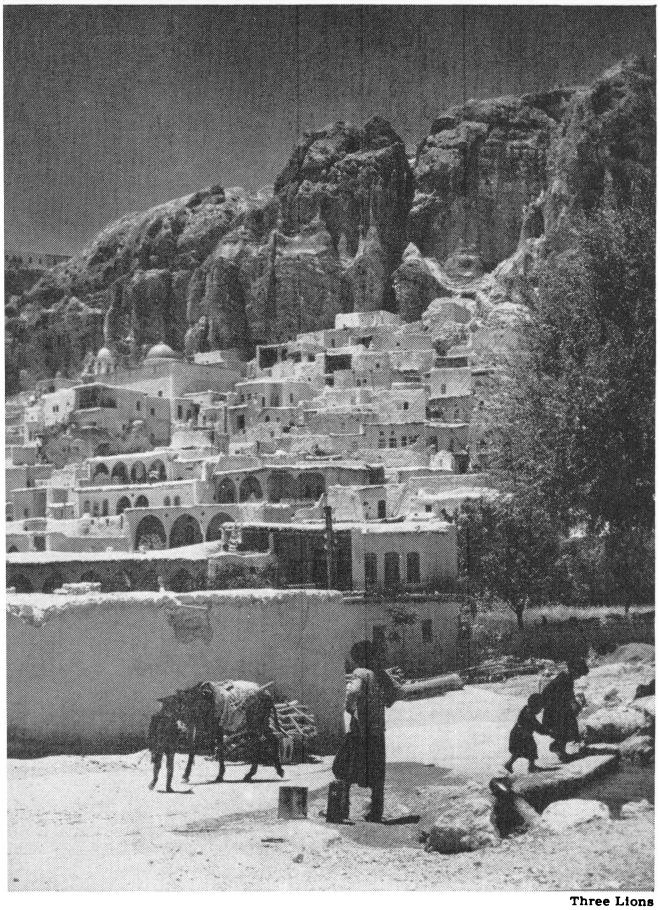
Recreation. Syracuse has 173 parks that cover about 2,300 acres (931 hectares). Thornden Park, with its amphitheater and famous Mills Rose Garden, is one of the city's most scenic parks. Among the nearby lakes are Ontario, Oneida, Cazenovia, and the Finger Lakes. State parks near Syracuse include Clark Reservation at Jamesville, Green Lakes State Park at Fayetteville, Chittenango Falls State Park near Cazenovia, and Selkirk Shores State Park on Lake Ontario. The Onondaga Indian Reservation, the capital of the Iroquois Confederacy, lies south of the city.

Industry and Trade. Syracuse is the market center for a large farming region. Syracuse factories make air-conditioning machinery, air-cooled engines, automobile parts, candles, chemicals, chinaware, clothing, drugs, electrical appliances, farm machinery, foundry and machine-shop products, lighting equipment, roller bearings, shoes, steam clothes-pressing machines, and television receivers.

History. The first settler, Ephraim Webster, opened a trading post in 1786. The village was incorporated in 1825. In 1847, Syracuse annexed the village of Salina and was chartered as a city. Syracuse has a mayor-council form of government. It is the seat of Onondaga County. WILLIAM E. YOUNG

SYRACUSE, BATTLE OF. See ARMY (Famous Land Battles of History).

SYRACUSE UNIVERSITY is a private coeducational school in Syracuse, N.Y. It offers courses in business administration, citizenship, education, engineering, fine arts, home economics, journalism, law, liberal arts, library science, nursing, public administration, social work, and speech and dramatic art. Forestry courses are taught at the State University of New York College of Environmental Science and Forestry adjoining the Syracuse campus. The university also directs a four-year liberal arts college in Utica, N.Y.; and University College, an adult education division, in downtown Syracuse. University College coordinates Syracuse educational programs at centers in New York and in Caen, France; Stratford-upon-Avon, England; Florence, Italy; and in Guatemala. Syracuse University was founded in 1870. For enrollment, see UNIVERSITIES AND COLLEGES (table). KENNETH G. BARTLETT



Three Lions

A Syrian Village in the Anti-Lebanon Mountains near the Syria-Lebanon border, lies one hour by car from Damascus.

SYRIA, *SIHR ee uh,* is an Arab country at the eastern end of the Mediterranean Sea. It lies at a strategic point on ancient trade routes linking the country with Europe, Asia, and Africa. For thousands of years, Syrians have been famous as merchants and traders, moving goods back and forth between Asia and Europe. Some of Syria's ancient cities are among the oldest in the world. Damascus, Aleppo, and Palmyra were probably founded as early as 2000 B.C. These cities grew up on caravan routes and became major trading centers.

Most of Syria's people depend on farming for a living. Syrian farmers raise grains and other food crops on fertile plains in northern and eastern Syria. This land lies at the western end of a stretch of rich farmland known for centuries as the *Fertile Crescent* (see FERTILE CRESCENT). Some Syrian tribes still wander across the Syrian Desert and east of the Euphrates River in search of water and grazing land for their goats and sheep.

Syria has been part of many empires since it was first settled about 3000 B.C. The writings of the Greek historian Herodotus in the 400's B.C. indicate that all the land between what is now Turkey and Saudi Arabia was once called Syria.

Modern Syria as an independent country dates from 1946. The country's official name in Arabic, the official language, is AL-JUMHURIA AL-ARABIA AL-SURIA (THE SYRIAN ARAB REPUBLIC). Damascus is the capital and the largest city.

Christina Phelps Harris, the contributor of this article, is Professor Emeritus of Political Science in the Division of International Relations at Stanford University and author of The Syrian Desert.

The Land

Size and Surface Features. Syria is about as big as the state of North Dakota. Rolling plains cover northern Syria. Plains called the *Jazirah* lie east of the Euphrates River. The Syrian Desert stretches south and west of the Euphrates, and ends to the west in the plains of the Hawran and the Anti-Lebanon Mountains, which form part of the border with Lebanon. Towards the south, the Syrian Desert extends deep into northern Saudi Arabia. The plains of the Hawran contain the *Jabal ad Duruz* (Mountain of the Druse).

The Euphrates River, which rises in Turkey, is the longest waterway in Syria. It is 2,235 miles (3,597 kilometers) long. For over 300 miles (480 kilometers), the river flows south, east, and then southeast through Syria's plains and desert. The Orontes River rises in Lebanon and flows north through Syria. The River Jordan rises in southern Syria. The Yarmuk River forms part of the boundary between Syria and Jordan.

Climate. Temperatures often rise above 110° F. (43° C) in the inland plains and desert regions of Syria in the summer. They drop to about freezing in these regions in the winter. The coast has a mild climate most of the year. The rainy season in Syria occurs between late October and May. But the desert may get less than 4 inches (10 centimeters) of rain a year, while as much as 40 inches (100 centimeters) often falls along the coast. From May through September, a scorching desert wind called the *khamsin* sometimes blows across the Syrian Desert into the coastlands.

Natural Resources. Syria's farmland forms most of the country's natural wealth. The plains produce most of Syria's livestock and crops. Syria has few minerals,

FACTS IN BRIEF

Capital: Damascus.
Official Language: Arabic.
Form of Government: Republic.
Head of State: President.
Area: 71,586 sq. mi. (185,408 km²). *Greatest Distances*—east-west, 400 mi. (644 km); north-south, 310 mi. (499 km). *Coastline*—100 mi. (161 km).
Elevation: *Highest*—Mount Hermon, 9,232 ft. (2,814 m) above sea level. *Lowest*—sea level, along the coast.
Population: *Estimated 1976 Population*—7,604,000; distribution, 53 per cent rural, 47 per cent urban; density, 106 persons per sq. mi. (41 per km²). *1970 Census*—6,303,000. *Estimated 1981 Population*—8,944,000.
Chief Products: *Agriculture*—barley, cotton, fruits, livestock, olives, pulses, sugar beets, wheat, wool. *Manufacturing and Processing*—cement, dried fruits, leather, processed food oils, soap, sugar, tobacco. *Mining*—asphalt, building stone, gypsum, oil.
National Anthem: "Homat El Diyar" ("Guardians of the Homeland").
Flag: The flag has three horizontal stripes of red, white, and black with a golden hawk coat of arms on the white stripe. See FLAG (picture: Flags of Asia).
National Holiday: Evacuation Day, April 17.
Money: *Basic Unit*—Pound. See MONEY (table: Values).

but it has a large supply of asphalt and building stone. It also has gypsum, natural gas, salt, some lignite, and a little chromium and iron ore. Oil deposits were discovered in northeastern Syria in 1956 and 1960, and a refinery built at Homs with the help of Czechoslovakia now provides many petroleum products.

Conservation. Farmers till only about half the land suitable for farming. But more land is gradually being put into use. In the 1950's, about 100,000 acres (40,000 hectares) of new farmland became available when engineers finished draining a swamp area on the Orontes River called the *Ghab*. In 1966, the Soviet Union agreed to help Syria build a dam on the Euphrates River west of Ar Raqqah. The project includes construction of several pumping stations and an electric power station. The irrigation this project provides will turn about 260,000 acres (105,000 hectares) of unused plains into productive farmland.

The People and Their Work

Most Syrians are Arabs. There are some non-Arab groups, including Kurds, Armenians, and a few Turks. About 6 out of 10 persons in Syria are farmers or shepherds. Their main crops are wheat, barley, and cotton, but they also raise fine quality figs, grapes, melons, olives, onions, lettuce, potatoes, sugar beets, and tobacco. Some large landowners use irrigation pumps, tractors, and other modern farm machinery. But farming methods in many parts of the country are still old-fashioned. Many Syrian farmers still plod along behind crude wooden plows pulled by oxen. During the late 1950's and the 1960's, the government purchased much land from wealthy landowners. The land was divided into small plots and sold or rented to peasant farmers.

Most of Syria's shepherds are wandering Bedouins. They raise sheep, goats, and cattle.

Manufacturing. The textile industry is Syria's largest single industry. Other large Syrian industries are those for making cement, sugar, and soap and for processing food oils and preserved fruits. Chief industrial centers are Damascus, Aleppo, Homs, and Latakia.

Syrian craftsmen are famous for their fine leather goods, brocades and embroideries, inlaid metalwork, and inlaid woodwork. Some silversmiths, leather craftsmen, and metal workers still work in open shops in the bazaars in many Syrian towns.

Trade. Most of Syria's foreign trade passes through Latakia, the country's main port. A second Syrian port is being planned at Tartus. Syria's chief exports are raw cotton, wool and other textiles, livestock, grains, and foodstuffs. The leading imported products are machinery and small cars, metals and minerals, and textiles other than cotton and silk. Most of Syria's foreign trade is with France, Great Britain, Italy, Russia, the United States, West Germany, Lebanon and other nearby countries, and countries in eastern Europe.

Transportation. For thousands of years, traders and conquerors traveled across Syria because it was a "land bridge" between Asia, Africa, and Europe. Caravans crossed the Syrian Desert plains and grasslands to avoid the mountains in the north and the rocky, waterless desert in the south. The routes linked the Nile River Valley and countries on the Mediterranean Sea in the west with the valley of the Euphrates and Tigris rivers and the Persian Gulf in the east. Syria's importance as a trade center decreased after 1498, when the Portuguese explorer Vasco de Gama became the first European to sail around Africa. Syria then lost much of its population and wealth. During the 1700's and 1800's, the country only partially regained its importance as a trade center.

Mattson, Black Star

Covered Streets shelter the bazaars of Damascus. Shopkeepers and pushcart peddlers sell products from all parts of the world.

Syria now serves as an important trade center for the Middle East. Modern Syria has more than 4,000 miles (6,400 kilometers) of surfaced roads and highways. During the dry season, cars can cross the desert over many of the wide routes that were packed and flattened by the plodding camels in ancient caravans. Railroads link Syria with Lebanon, Turkey, Iraq, and Jordan. An airport near Damascus provides international air service. Two oil pipeline systems cross Syria's deserts, one from Iraq and the other from Saudi Arabia. Transit fees for

Syria is about one-fortieth the size of the United States, not counting Alaska and Hawaii.

WORLD BOOK map

Location of Syria

Consulate General of Syria

The Modern Campus of Damascus University is much like those of many universities in the United States. Graduates of the university have taken an important part in developing many Middle Eastern countries.

the pipelines, which carry oil to Mediterranean ports, are a major source of income for Syria.

Social and Cultural Achievements

Education. Syria has over 4,000 primary schools and about 400 secondary schools. About 12 per cent of the schools in Syria are either private or foreign-operated schools. Elementary and secondary education is free in all the state schools. Children between the ages of 6 and 11 must attend school. But there are many people living in the desert or in the remote mountain villages of the country who cannot read or write.

Syria has two universities, Damascus University and the University of Aleppo. The Damascus University Faculty of Medicine, opened in 1901, is the only medical school in the world that gives its courses in Arabic. The Academy of Damascus, a learned society, was founded in 1919.

The Arts. Syrian authors and poets have written many famous works. The most noted Syrians include the philosopher al-Farabi (872-950) and the poet al-Mutanabbi (915-965). Well-known poets today include Shafiq Jabri, Omar Abu-Rishe, Khalil Mardam, and Nizar Kabbani. Syria's many accomplished novelists and short-story writers include Shakib Jabri and Tawfik Awad. Said Taqieddine is a noted playwright. Mohammed Kurd Ali, a former president of the Academy of Damascus, was a distinguished historian.

The Arab's love of his language and the graceful nature of Arabic lettering have led to highly developed *calligraphy*, the art of beautiful writing or penmanship. Designs of Arabic lettering decorate buildings and jewelry and many other things in Syria.

Two well-known Syrian artists are Rafat Buhairi and Michel Kurshe. Wadi Sabra has been the chief leader of a recent movement to develop Syrian musical talent. He has composed operas in Arabic and French. The violinist Alexis Butros founded the first Syrian national conservatory of music in 1924.

Religion. About seven out of every eight Syrians are Moslems. There are more than 2,300,000 Sunni, or Orthodox Moslems, who form the largest group. There are also more than 400,000 Alawis and about 115,000 Druses, members of two strong unorthodox Islamic sects. About one out of every 12 persons in Syria is a Christian. There are nine important Eastern Christian denominations in Syria, including the Greek, Armenian, and Syrian Orthodox churches.

IMPORTANT DATES IN SYRIA

c. 2300 B.C. An Arab ruler of Babylon, Sargon of Akkad, controlled northern Syria.
c. 1000 B.C. The Aramaeans established kingdoms in Syria.
720 B.C. The Assyrians conquered Syria.
538 B.C. Cyrus the Great added Syria to the Persian Empire.
333 B.C. Alexander the Great defeated the Persians at the Battle of Issus and conquered Syria.
64-63 B.C. Pompey made Syria a Roman province.
A.D. 636 Moslem Arabs defeated the Christians of the Byzantine Empire at the Battle of the Yarmuk.
1516 The Ottoman Turks conquered Syria.
1916 The Arabs revolted against Turkish rule.
1920 France took Syria as a League of Nations mandate.
1946 Syria gained complete independence from France.
1958 Syria and Egypt formed the United Arab Republic.
1961 Syria withdrew from the United Arab Republic.
1967 Syria, Egypt, and Jordan were defeated by Israel in a six-day war.
1973 Syria joined several other Arab nations in another full-scale war against Israel.

History and Government

Early Days. Early Syria lay between the Egyptian civilization in the valley of the Nile River and the Sumerian and Babylonian civilizations in the valleys of the Euphrates and Tigris rivers. Syria's great stretches of grassland and rich soil made it a valuable prize. As a result, Syria was a constant battleground, and became part of many empires.

The first people to settle in Syria were Arab nomads, who probably came from Arabia about the year 3000 B.C. These nomads gradually settled in the Fertile Crescent, which formed three-fourths of a circle around the Syrian Desert.

The Amorites were the first nomads to settle west of the desert. The Phoenicians who came from the Persian Gulf area, drifted across the Syrian Desert into the coastal regions of what is now northern Syria, Lebanon,

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Cities and Towns

Abtin	4,340	A 2	Ash Shaykh Miskin	3,769	C 2	Dayr Baalbah	5,434	B 2	Khan Shaykhun	5,710	B 2	Qatana	9,792	C 2
Abu Kamal	8,075	B 4	As Safirah	5,944	A 2	Dayrik	4,764	A 5	Latakia	85,993	B 1	Qulaydin	4,722	B 2
Ad Dana*	3,297	A 2	As Salamiyah	30,156	B 2	Duma	34,754	C 2	Maarrat an Numan	19,045	B 2	Ras al Ayn	4,702	A 4
Adhra*	3,196	C 2	As Sanamayn	3,574	C 2	Dumayr	4,738	C 2	Maarrat Misrin	5,284	A 2	Sadad	3,471	B 2
Afrin	6,739	A 2	As Saqlabiyah	6,571	B 2	Fiq	2,769	C 1	Madaya*	4,209	C 2	Salkhad	5,833	C 2
Al Bab	31,366	A 2	As Suwayda	19,418	C 2	Fua*	3,353	B 2	Manbij	15,479	A 2	Saqba*	4,181	C 2
Aleppo	578,861	A 2	At Tall*	12,795	C 2	Hama	142,968	B 2	Mari	4,607	A 2	Saraqib	5,153	B 2
Al Haffah	5,344	B 2	Ayn al Arab	4,925	A 3	Harasta al Basal	9,740	C 2	Masyaf	8,880	B 2	Sarmin	3,800	B 2
Al Harrah	3,266	C 2	Azaz	15,345	A 2	Harim	8,423	A 2	Minin	3,594	C 2	Shahba	3,721	C 2
Al Hasakah	17,576	A 4	Az Zabdani	11,241	C 2	Homs	198,852	B 2	Muhassan	4,114	A 3	Shahil	2,924	B 4
Al Jayyid	7,359	B 2	Bab Bila*	3,670	C 2	Idlib	42,030	B 2	Muhradah	8,514	B 2	Shin	3,619	B 2
Al Kanisah*	4,081	B 1	Bab Umar*	5,734	B 2	Irbin*	9,202	C 2	Mulayhah*	3,170	C 2	Subaykhan	3,913	B 4
Al Kiswah	4,894	C 2	Baniyas	10,609	B 1	Izra	3,702	C 2	Nawa	8,115	C 2	Suran	5,029	B 2
Al Mayadin	14,015	B 4	Binnish	4,355	B 2	Jablah	18,763	B 1	Nayrab	13,076	A 2	Tadif	5,611	A 2
Al Muazzamiyah*	5,372	C 2	Bludan*	3,387	C 2	Jarabulus	8,901	A 3	Nubul	4,021	A 2	Tafas	5,070	C 2
Al Qamishli	22,423	A 4	Burj Safita	13,047	B 2	Jaramanah*	6,480	C 2	Palmyra	12,159	B 3	Tall Bisah	6,508	B 2
Al Qaryatayn	5,246	B 2	Busra ash Sham	4,523	C 2	Jawbar	27,289	C 2	Qalat al Madiq*	3,992	B 2	Tall Kalakh	7,191	B 2
Al Qunaytirah	27,378	C 1	Dail*	4,480	C 2	Jayrud	5,799	C 2	Qara	4,283	B 2	Tall Rifat	3,969	A 2
Al Qusayr	10,126	B 2	Damascus	618,457	C 2	Jisr ash Shughur	15,212	B 2	Qardahah*	3,107	B 1	Tartus	23,381	B 1
Al Qutayfah	5,501	C 2	Damsarkhu	4,298	B 1	Judaydat Artuz*	3,420	C 2	Qasim	4,542	C 2	Tayyibat al Imam*	3,363	B 2
Amuda	12,557	A 4	Dara	23,634	C 2	Kafr Batna*	3,005	C 2	Qatah	2,915	B 4	Yabrud	9,528	C 2
An Nabk	17,782	B 2	Darayya	15,135	C 2	Kafr Buhum	3,550	B 2						
An Nakhl	3,946	C 2	Darbasiyah	6,412	A 4	Kafr Lahah	3,395	B 2						
Ansari	3,976	A 2	Dar Taizzah	3,642	A 2	Kafr Nabal*	3,417	B 2						
Ariha*	14,405	B 2	Dayr Atiyah	5,177	B 2	Kafr Takharim	4,539	A 2						
Armanaz*	3,445	A 2	Dayr az Zawr	67,419	B 4	Khan ash Shaykh	3,611	C 2						
Ar Raqqah	17,051	B 3												
Ar Rastan	11,063	B 2												
Ar Ruhaybah	5,228	C 2												
Arwad	3,558	B 1												

Physical Features

Anti-Lebanon Mts.	C 2	Khabur River	B 4
Euphrates River	B 3	Mediterranean Sea	B 1
Galilee, Sea of	C 1	Mt. Hermon	C 1
Jabal ad Duruz (mountain)	C 2	Orontes River	B 2
		Syrian Desert	C 3

Sources: Latest official estimates (1966) for provincial capitals; 1960 census for other places.
***Does not appear on the map; key shows general location.**

and Israel. Around 2900 B.C., they became great sea traders. Their ships carried *papyrus*, the world's first paper, from Egypt to the Greeks. They also founded Carthage, near present-day Tunis in northern Africa. By 1500 B.C., the Phoenicians had invented, or more probably perfected, the alphabet that became accepted by the Western world. The Amorites settled in northern Syria sometime after 2500 B.C.

The earliest Syrian Arabs to live east of the desert were the Akkadians. About 2300 B.C., King Sargon of Akkad conquered all of Babylonia and Sumer, which were located along the south part of the Euphrates River. The area became part of the Sumero-Akkadian Empire. Sargon also conquered northern Syria and ruled as far west as the Mediterranean coast. About 1900 B.C., the Amorites began to take Babylonia and the rest of the Sumero-Akkadian Empire. After the Amorites completed their invasion, they made Babylon their capital. The sixth Amorite King of Babylonia was Hammurabi. He gave the people living in the Fertile Crescent their first law code (see HAMMURABI).

As the Amorites of Syria expanded into Babylonia, the Hittites began to build up their first empire north of Syria in what is now Turkey (see HITTITE). The Hittites later began to move into northern Syria. At the same time, Hebrews had begun to come into the interior of southern Syria. Abraham and his tribe supposedly migrated to southern Syria from the famous Sumero-Babylonian city-state of Ur. Rulers of the powerful Second Hittite Empire, which lasted from about 1400 to 1200 B.C., invaded and occupied all of northern Syria. The Syrian Arabs and the Hebrews were then caught between the warring Egyptian and Hittite armies as they fought for Syria. But by 1150 B.C., both the Hittite and Egyptian empires had fallen, and their fighting in Syria had ended.

The Arameans. Northern Syria by then had become the home of the Arameans, who started coming into Syria from the Syrian Desert at the beginning of the 1200's B.C. The Arameans established flourishing kingdoms in Syria around 1000 B.C. at such places as Damascus, Homs, Hama, and Aleppo. They became great land merchants, and most of the people living in the Fertile Crescent came to speak their language, Aramaic. Jesus and the apostles spoke Aramaic, and parts of the Old Testament were written in Aramaic.

By 1000 B.C. the Arameans in northern Syria, the Hebrews in southern Syria, and the Phoenicians along the coast held most of the western side of the Fertile Crescent. After 1000 B.C., the Hebrews continued to conquer southern Syria, and this region became known as Palestine.

The Arameans became so prosperous that Assyria, a country to the northeast that covered much of what is now Iraq, went to war against them. Mighty Assyrian armies finally overran all of Syria and the Phoenician coastlands. They captured Damascus in 732 B.C. and Hama about 720. The fall of Hama ended the Aramean kingdoms of Syria, and Syria became part of the Assyrian Empire. About 100 years later, Syria was conquered by the Chaldeans and became part of the new Babylonian empire. In the 500's B.C., Persians led by Cyrus the Great conquered the Chaldeans and united all of western Asia for the first time in the Persian Empire (see PERSIA, ANCIENT).

The Greeks came to Syria next. When Alexander the Great defeated the Persians at Issus in 333 B.C., he gained control over the Fertile Crescent. Alexander and his Macedonian successors introduced the Greek language into Syria, and founded many Greek colonies and cities in Syria, including Antioch, which is in present-day Turkey. After Alexander's death in 323 B.C., his empire was divided among his generals. One of them, Seleucus, received Persia and all of the Fertile Crescent except the southern part of Syria. Seleucus became the first ruler of the Seleucid Dynasty, which governed Syria until the Roman general Pompey conquered the whole region in 64-63 B.C. For almost 700 years, Syrians lived under a highly developed system of Roman law. During the period, Syria flourished as a Christian Arab country, first in the Eastern Roman Empire and later the Byzantine Empire.

The Moslem Arabs. In A.D. 636, four years after the death of the prophet Mohammed, his followers defeated a Byzantine Empire army in Syria. Northern and southern Syria then became a Moslem Arab land, and later, Damascus became the capital of the great Omayyad Caliphate. This empire stretched to India and included all the land along the north African coast to the Atlantic Ocean. The people gradually began speaking Arabic, instead of Aramaic and Greek. The Islamic religion largely replaced Christianity, but the Moslems allowed the Christians to practice their religion.

About A.D. 750, the Abbasid Caliphate succeeded the Omayyad rule. From Baghdad, the capital of modern Iraq, the Abbasid caliph ruled over all of Syria and a large part of north Africa, including Egypt. About 400 years later, Seljuk Turks from Central Asia conquered and ruled Syria briefly.

Christian Crusaders from Europe invaded Syria at the end of the 1000's, hoping to win back the Fertile Crescent for Christianity. They set up small Crusader states along the Syrian coasts and in Palestine between 1097 and 1099. But they were driven back to the Syrian coast by Saladin, the great Moslem ruler of Egypt. By the 1100's, Saladin ruled all of Syria except for a few Crusader towns. Later, the Mamelukes, war captives of mixed origin who were enslaved by Saladin's successors, revolted against their masters and gained control of Egypt. The Mameluke Sultans of Egypt ruled all of Syria for about 250 years except for a brief period when they lost control to Mongols (Tatars).

The Ottoman Turks from central Asia became the last great conquerors of Syria. The Ottomans were converts to the Islamic religion. They had taken Constantinople in 1453. In 1516, they captured all of Syria and the next year they took Egypt. The Turks ruled the Fertile Crescent for the next 400 years.

Before World War I started, the Arabs demanded home rule within the Ottoman Empire. In 1916, the Arabs revolted against the Turks and helped break up the Ottoman Empire. Great Britain supported the Arabs. See ALLENBY, LORD; LAWRENCE, THOMAS E.

After World War I, the League of Nations gave France a mandate to administer Syria. This meant that France was to rule Syria until it could become independent. In 1920, a southwestern coastal region was carved out of Syria, becoming a separate province

known as Greater Lebanon. France brought many Western ideas to the Syrian and Lebanese peoples. But the Syrians never welcomed French rule. The French caused discontent when they put down a rebellion between 1925 and 1927. In 1930, the French high commissioner in Syria drew up a constitution that made Syria a republic. But the government under this constitution was suspended at the outbreak of World War II.

Independence. British and Free French forces drove the German-controlled Vichy French out of Syria in 1941. The Free French then promised some independence to Syria, but they did not give up control. In August, 1943, Shukri al-Kuwatly was elected president of Syria. In 1944 and 1945, French troops in Syria tried to prevent the country from becoming independent. But in 1945, Syria was recognized as an independent republic and joined other Arab countries in forming the Arab League to promote political cooperation and trade (see ARAB LEAGUE). The last French troops left Syria on April 17, 1946. This date, called Evacuation Day, is celebrated as Syria's date of independence.

After Syria became independent, the Syrians tried to keep their republican institutions and government. But army forces ousted the government, and a series of strong-man governments followed. Each revolt introduced new policies or a new constitution.

President al-Kuwatly was forced out of office by Husni Zayim, an army officer, in March, 1949. Zayim was overthrown and executed in August by another army officer, Sami Hinnawi. After an army revolt in December, Hashim al-Atasi became president, backed by an army officer, Adib Shishakly. Shishakly was dictator from December, 1949, to February, 1954.

In July, 1953, the Syrian people adopted a new constitution and elected Shishakly president. This constitution gave women the right to vote. But eight months later, the army seized control again and forced Shishakly into exile. Hashim al-Atasi again became president. The parliament returned Shukri al-Kuwatly to power as president in August, 1955, and he served until 1958.

The United Arab Republic, a union of Syria and Egypt, came in 1958. Syrian leaders had been divided since the late 1940's. They actively supported Arab unity after the Arab-Israeli war of 1948-1949, but they disagreed on the best way to achieve unity. Some favored Syria's independence. Some favored close ties with Iraq, and others supported union with Egypt.

Egypt and Syria took the first steps toward union in 1955, when they signed a defense agreement. In 1956 and 1957, they made plans for an economic union. Then in 1958, the Syrian government, fearing that Communists might take over the Syrian government, asked for immediate political union with Egypt.

Egypt agreed to the union if Syria would adopt Egyptian laws. Syria agreed, and on Feb. 1, 1958, Egypt and Syria formed the United Arab Republic. Gamal Abdel Nasser, president of Egypt, became president of the U.A.R., and took control of Syrian affairs. Syrian political parties were disbanded, and Syrian citizenship was abolished. Both peoples were designated as *Arabs*.

Syria Leaves the U.A.R. In September, 1961, Syria left the U.A.R. The break came after the republic's legislators in Cairo passed laws nationalizing many industries. Many of Syria's army officers also disliked the appointment of Egyptian officers to high posts in the Syrian army. Since then, politics have been unstable in Syria. Members of the Syrian socialist Baath Party, which came to power in 1963, believe that Syrian landlords have too much power. The landlords oppose land reform, which breaks up large estates and gives peasants small plots of land. Religious leaders oppose an increase in nonreligious trends. The Baath Party itself split into moderate and extremist factions.

The Syrian government changed hands seven times between 1962 and 1966. The Baath extremists gradually gained the upper hand. The government took control of about a fourth of the farmland, most of the industry, and all international trade in Syria. Early in 1963, Syria tried to join a new U.A.R. being formed by Egypt and Iraq, but this union also failed.

Recent Developments. In 1966 and 1967, Syria and Egypt agreed to an economic and military alliance to try to prevent Israel's diversion of the River Jordan's waters. But Israel succeeded. Fighting broke out in June, 1967, and Israel defeated Syria, Egypt, and Jordan. Israel occupied the Golan Heights in Syria, and also parts of Jordan and Egypt. Syria refused to support a United Nations resolution setting forth broad terms for a peace settlement. Some fighting between Syria and Israel continued along the cease-fire line. Tension was increased by the presence in Syria of about 140,000 Palestinian refugees from Israeli-held territory.

In 1969, a new power struggle within the Baath Party resulted in a policy of closer cooperation with other Arab states against Israel. In 1973, Syria adopted its first permanent constitution since 1961. The constitution established Syria as a socialist state.

In October, 1973, Syria joined Egypt and other Arab nations in a new war against Israel. Cease-fires ended most of the fighting by November. But clashes between Syria and Israel continued through May, 1974, when the two nations agreed to a separation of their forces in the Golan Heights.

CHRISTINA PHELPS HARRIS

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Outline

I. The Land
II. The People and Their Work
III. Social and Cultural Achievements
IV. History and Government

Questions

What are the leading products of Syrian craftsmen?
What is the occupation of most workers in Syria?
What ancient routes do automobiles use during the dry season?
What is *calligraphy?* How do Syrian artists use it?
What event does Evacuation Day celebrate?
When did Syria join and leave the U.A.R.?
What is the chief religion in Syria?

SYRIAN DESERT is a triangular desert plateau that extends northward from the An Nafud desert of northern Arabia. For location, see SAUDI ARABIA (map). It lies roughly between 30 and 36 degrees north latitude. The plateau is from 2,000 to 3,000 feet (610 to 910 meters) above sea level on the west. It slopes downward to the Euphrates River, its eastern boundary. The southern two-thirds of the plateau is rocky. A volcanic zone on the west is dotted with huge boulders of black basalt. The *Jabal Unayzah*, a mountainous area about 3,000 feet (910 meters) high, stands above the central part of the plateau. Deeply cut *wadis* (dry watercourses) wind down from it to the Euphrates.

The northern third of this triangular plateau is a flat sandy plain that forms the natural bridge between Syria and Iraq. A chain of limestone hills rises along the western edge of the plain. The desert contains historic ruins and several towns that have grown up around *oases* (watering places). The famous caravan city of Palmyra is the best known of these towns.

Two motor highways have been built across the desert. Pipelines connect the oil fields of northern Iraq and of eastern Saudi Arabia with the Mediterranean Sea. CHRISTINA PHELPS HARRIS

SYRINGA. See MOCK ORANGE.

SYRINGE is a pumplike device. It is a tube, tapered at one end, with a plunger or soft, hollow bulb at the other. The plunger or bulb either creates suction or forces fluid from the syringe. Syringes are used to spray or inject liquids, or to remove them by suction. See also HYPODERMIC INJECTION; INTRAVENOUS INJECTION.

SYRINX. See ORGAN (History); PAN.

SYRUP, or SIRUP. See CORN (Uses of Corn); MAPLE SYRUP; SORGHUM; SUGAR.

SYSTEM. See BIOLOGY; HUMAN BODY (Systems).

SYSTEMIC CIRCULATION. See CIRCULATION.

SYSTEMS ANALYSIS is the study of how the parts of a system work together. A system is any group of people, machines, or other elements that work together to do a certain job.

Systems analysis tries to find the best way for a system to accomplish its task. For example, a high school is a system that includes students, teachers, and classrooms. Systems analysis can develop student schedules that make the most efficient use of the teachers and classrooms. It is used in many fields, including the armed forces, business, economics, government, industry, the sciences, and transportation.

Systems analysis usually uses advanced mathematics to study a system. First, a systems analyst uses mathematical equations to describe the different parts of the system. These equations make up a *mathematical model* of the system. Then the model is analyzed according to the principles of logic (see LOGIC). The analysis of a mathematical model requires the solution of long, difficult mathematical problems. Systems analysts use electronic computers to help find the answers to these problems. The techniques of systems analysis were developed during the late 1930's. The later development of electronic computers resulted in the widespread use of systems analysis. DONALD G. SAARI

SYSTEMS ANALYST. See SYSTEMS ANALYSIS; COMPUTER (Planning a Program; Careers).

SYSTOLIC PRESSURE. See BLOOD PRESSURE.

SZCZECIN, *shcheh TSEEN*, or in German, STETTIN (pop. 339,800), is the leading port of Poland. The city lies on the Baltic Sea at the mouth of the Oder River (see POLAND [political map]). Szczecin serves as a port for Czechoslovakia, East Germany, and Hungary, as well as for Poland. The city produces machines, metals, paper, and ships. Szczecin became part of Poland at the end of World War II in 1945. The city had previously formed part of Germany. ADAM BROMKE

SZEGED, *SEH gehd* (pop. 132,145), is a commercial and industrial city in southern Hungary. It lies at the junction of the Tisza and Maros rivers (see HUNGARY [map]). Szeged serves as the market for a fertile farming area and handles trade in grain, wool, and tobacco. Its factories produce textiles, tobacco products, and such food items as paprika and salami. After a disastrous flood in 1879, most of Szeged was rebuilt with broad streets and beautiful public squares. Places of interest include a church tower built in the 1200's, a university, and a museum. GEORGE BARANY

SZELL, *sehl*, **GEORGE** (1897-1970), was a Hungarian-born musician known principally as a symphony orchestra conductor. Earlier in his career, he was equally noted as a composer and pianist. From 1946 until his death, Szell conducted the Cleveland Symphony Orchestra, which he built into one of the world's great orchestras. Szell's extraordinary sense of pitch and rhythm helped make him one of the most respected conductors among musicians.

Szell was born in Budapest. During the 1920's and 1930's, he established himself as a conductor of operas, particularly those of Richard Wagner. He later concentrated on conducting orchestral music. Szell became a United States citizen in 1946. KEITH POLK

SZENT-GYÖRGYI, *SENT DYER dee*, **ALBERT** (1893-), an American biochemist, discovered actin, a muscle protein. He received the 1937 Nobel prize for physiology or medicine. Through his research, Szent-Györgyi explained the catalytic action in cellular oxidation, the role of vitamins in metabolism, and the chemistry and structure of muscle tissue. He wrote *Chemistry of Muscular Contraction* (1947). He was born Albert Szent-Györgyi von Nagyrapolt in Budapest, Hungary. He became a U.S. citizen in 1955. PAUL R. FREY

SZIGETI, *SIHG ih tee*, **JOSEPH** (1892-1973), was a famous Hungarian-born violinist. He performed works by many leading modern composers, including the première of compositions by Ernest Bloch and Sergei Prokofiev. Szigeti was born in Budapest and studied with the violinist and composer Jenö Hubay. Szigeti became internationally famous as a child prodigy on the violin. He settled in the United States in 1926 and became a U.S. citizen in 1951. DOROTHY DELAY

SZILARD, *ZIL ahrd*, **LEO** (1898-1964), an American physicist, pioneered in the development of nuclear energy. With Enrico Fermi, he originated the method of arranging graphite and uranium which made possible the first self-sustaining nuclear reactor in 1942. In July, 1939, Szilard and Eugene Wigner visited Albert Einstein. Einstein then wrote to President Franklin D. Roosevelt and initiated federal support of nuclear energy. Szilard was born in Budapest, Hungary. He became a U.S. citizen in 1943. He and Wigner shared the 1959 Atoms for Peace Award. CHALMERS W. SHERWIN